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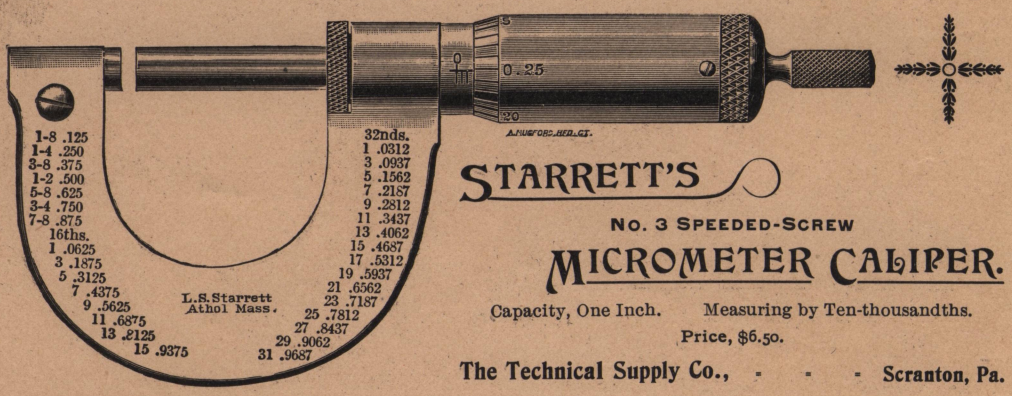

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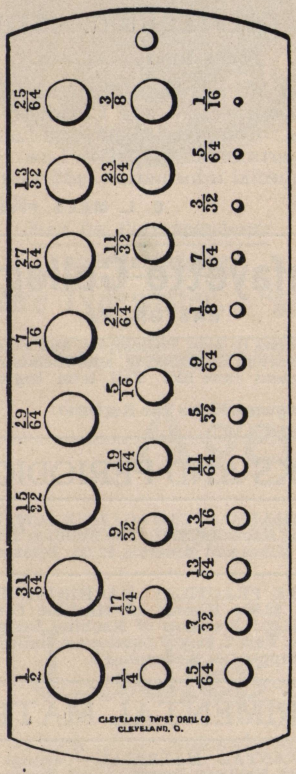

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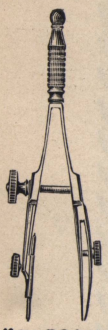

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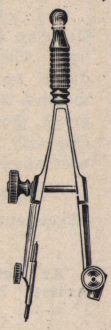

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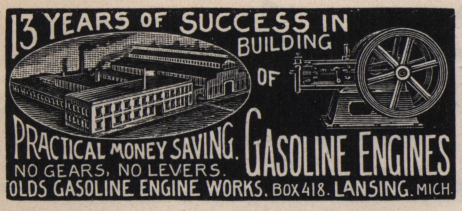
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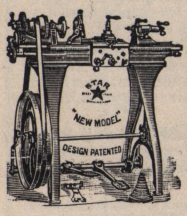

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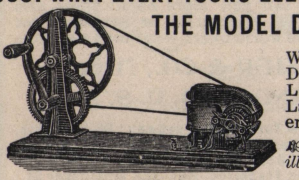

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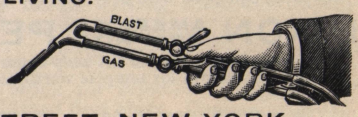

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THE MECHANIC ARTS MAGAZINE.

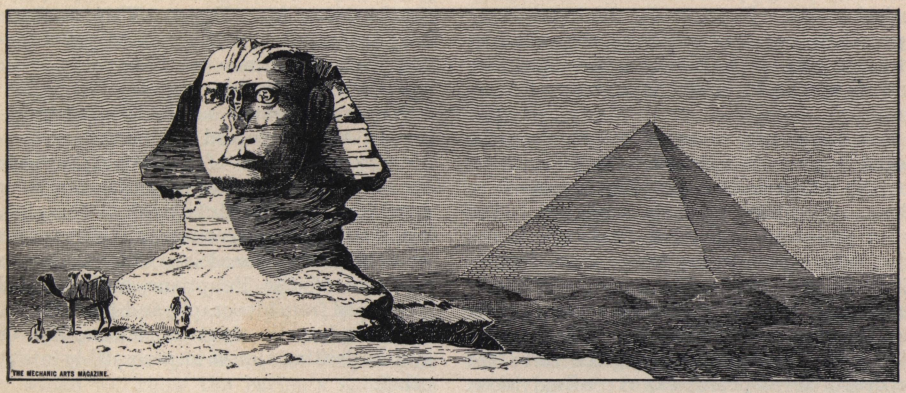
Vol. IV. APRIL, 1899. No. 3.

THE ALPHABET, AND THE ART OF LETTERING.

Chas. J. Allen.

THE ORIGIN OF OUR ALPHABET—PICTURE WORDS OF THE ANCIENTS—EGYPTIAN HIEROGLYPHICS—DISADVANTAGES OF THE CHINESE ALPHABET—HOW TO READ.

PART I.



THE SPHINX AND THE GREAT PYRAMID IN EGYPT.

IS IT foolish to hope that, when the reader sees the title of this article, he will *not* turn over the page in search of something more interesting? Of course, if he knows all he cares to about the twenty-six little signs that he learned, when only about "so high," to repeat from *A* to *Z*, it will be natural for him to leave the article alone; but there are so few people who know anything whatever about them beyond their mere position in the alphabet, that we venture to hope he will have patience and stay with us for a few minutes, while we endeavor to interest him in their history.

No one will deny that the ability to read and write is of vital importance; and it will be admitted at once that it is absolutely necessary to know what the words, either read or written, mean. Yet there are comparatively few people who know *why* a word means what it does. Take the word *lithograph*, for instance; how many recognize, every time they speak it, read it, or write it, the two Greek words from which it was derived, namely, *lithos*, "a stone," and *grapho*, "I write"? And so with the letters of the alphabet: how many, when looking at the letter *a*, recognize in it the Greek *alpha*, and then remember that this was derived from the Hebrew *aleph*, meaning "ox"?

It is because we earnestly wish those who

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are interested in practical lettering to know more than merely how to *form* the letters that we begin with a brief account of their origin, not attempting to deal separately with each individual letter, but to tell in a general way of the various stages in their development, and to show that the letters now used are the result of a slow and gradual growth that began thousands of years ago.

Consider for a moment how closely the growth of the alphabet has been connected with every advance in the general intelligence of man, until now practically everything that is known is written down in one form or another, and that so plainly and by means of so perfect an alphabet that the child may read and understand. Compare this condition of things with that of the ancient Egyptians. If their work had not been left in the form of imperishable monuments of stone—like the pyramids and obelisks—of metal coins, of pottery, and so forth, we would now be in utter ignorance of the early forms of writing, for it is upon them that we find the hieroglyphic records of ancient historical events. Fortunately, the inscriptions upon these relics of antiquity are sufficient to form way-marks through the centuries, and to tell us in brief the history of those times.

It is a generally accepted fact that writing began with rude pictures of objects, made for the purpose of conveying sequences of ideas, and hence termed *ideographs*. The word *ideograph* is derived from the Greek *idea*, which means the same as it does in English, and *grapho*, "I write." The pictures used gradually became mere conventional signs, and finally the letters of an alphabet. But we are going too fast; the process of development was exceedingly slow.

In speaking of the writing of the ancient Egyptians, we have used the word *hieroglyphic;* this is derived from the Greek *hieros*, "sacred," and *gluphein*, "to carve," and means literally "sacred carving or writing." The Egyptians used hieroglyphics to represent either objects or sounds, or a combination of both. This led, as will be shown, to the *phonetic* alphabet now used. The word *phonetic* is derived from the Greek *phonos*, "sound," and means "representing articulate sounds, or speech." Here, the various signs have in themselves no meaning whatever; they merely indicate particular articulate sounds—the number of possible combinations of them, and therefore the number of words that it is possible to make with them, being practically infinite.

At the present time there is one great nation that has never advanced beyond the ideographic period, and this nation—the Chinese—instead of now possessing a condensed alphabet, have, by gradually adding character to character, accumulated a stock of over 40,000 different and independent characters, each representing a single sense of a word. To show, by comparison, the advantage of our system: A boy of 12 years in an American school reads and writes English with a facility that would take a student of Chinese twenty-five years to acquire.

The changes that gradually transformed the first ideographs to the letters now used were of course very gradual, and the earliest of them we know nothing of; indeed, we are satisfied to carry the reader's mind no further back than the hieroglyphic period of the Egyptians. There are positively no records, either in the form of inscriptions on monuments or otherwise, to show that any development of the ideographic towards the present system began before the exodus of the Israelites from Egypt. This carries us back to the year 1491 B.C.—3,390 years ago—and we must remember that prior to this was the hieroglyphic period.

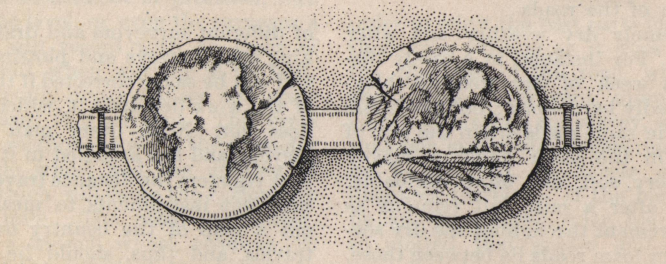
We are indebted to the Phœnicians—a people that occupied a narrow strip of country northwest of Palestine, bordering on the Mediterranean—for the marvelous developments that finally led to the alphabet of today. On account of their maritime knowledge, the Phœnicians advanced beyond the arts of the Egyptians, and gradually developed from ideographs and hieroglyphics certain phonetic signs or letters, the one system drifting almost imperceptibly into the other.

For the benefit of those that are not familiar with ancient history, the mention of a few important events will serve to make this article of more profit and interest. After the exodus of the Israelites in 1491 B.C., we come to an independent alphabet given by the Hebrews; this was followed a few centuries later by the Greek alphabet, as gradually evolved by the Phœnicians. About 540 B. C. the empire of Babylon was established, and between that time and the beginning of the Christian era there followed the Medo-Persian, Grecian, and Roman empires. During these five centuries the policy of the nations was aggressive, as opposed to the tranquility of what may be termed "hieroglyphic Egypt," and great changes were made in the forms of writing.

Through all the changes, however, the permeating influence of the Hebrew is distinctly traceable. The early Hebrew characters were rounded—quite different from the present square characters—but the names of the letters were the same as they are now, each letter having a significant meaning. Where we, in our alphabet, have *a*, *b*, *c*, *d*, the Hebrews have *aleph* (ox), *beth* (house), *gimel* (camel), *daleth* (door); the similarity between the Hebrew and the Greek is very noticeable; thus, in Greek we have for the above, *alpha*, *beta*, *gamma*, *delta;* but these, unlike Hebrew, have no significant meaning.

It would be impossible in a magazine article like this to show by means of illustrations how various ideographs or hieroglyphics were gradually changed until they became letters of our alphabet. Indeed, it is not possible to separate and definitely trace to their origin the numerous forms of writing that have existed, people who claim to see positive identity between even the hieroglyphic and the Hebrew characters having to draw largely upon their imagination. One thing, however, we do know: the great change from a language consisting of thousands of independent picture words, to one having as a complete key a simple alphabet of twenty-six letters, was accomplished, and we, without having done anything but take what was ready prepared for us, constantly benefit by it. We have only to look at China to see the fatal consequences of clinging to the ideographic form. And in this connection it is interesting to note in how many ways we do even now make use of ideographic characters; for example, $, £, ℔, %, =, √, +, −, ×, ÷, @, are ideographs; so are the three balls over the pawnbrokers, the striped pole by which we know the barber's shop, the Indian outside the cigar store; so are the flags of the nations, family crests, trade marks—all of them, ideographs. It is as well therefore to hesitate, before we smile at the ignorance of the Egyptians or pity their inability to write in a manner that is at once intelligible to us. Their language is one of words, ours is one of letters; and therein lies the secret of our ability to flash a cable message telling those in the western hemisphere news of the Orient, so that we may read of an event in the morning paper at an earlier hour in the solar day than that of its actual occurrence; it is these letters that make it possible for the mere tick of a key and sounder to be translated into words and sentences, and thus into a message that the whole world may partake of simultaneously.

One thing every one should guard against, and that is, looking upon words as mere signs or pictures, and forgetting the importance of the syllables and letters. Every word has a derivation, a history; a few derivations have been given here. It should be the aim of every man to know the meaning of every word he uses or reads, not simply "by heart"—that is, from memory—but intelligently. Read what John Ruskin says in his famous lecture on books and how to read them: "And, therefore, first of all, I tell you, earnestly and authoritatively (I *know* I am right in this), you must get into the habit of looking intensely at words, and assuring yourself of their meaning, syllable by syllable—nay, letter by letter. For though it is only by reason of the opposition of letters in the function of signs, to sounds in function of signs, that the study of books is called 'literature,' and that a man versed in it is called, by the consent of nations, a man of letters instead of a man of books or of words, you may yet connect with that accidental nomenclature this real principle—that you might read all the books in the British Museum (if you could live long enough), and remain an utterly 'illiterate,' and uneducated person; but that if you read ten pages of a good book, letter by letter—that is to say, with real accuracy—you are for evermore in some measure an educated person. The entire difference between education and non-education (as regards the mere intellectual part of it) consists in this accuracy."



A Cæsar Augustus Penny Belonging to the Writer.

SURVEYING WITH BICYCLE AND CYCLOMETER.

Louis Allen Osborne.

THE ACCURACY OF THE CYCLOMETER AS A MEASURING INSTRUMENT—METHOD OF TAKING NOTES—LANDMARKS—PLOTTING THE MAP FROM THE NOTES.

IT IS probably safe to say that, as an educator, no machine ever invented has equaled the bicycle. Men, women, and even children have become amateur mechanics on a small scale through their efforts to effect temporary roadside repairs or adjust the bearings of their wheels; while the farmer, impressed with the reports of the several cyclists who daily pass his house, has finally come to acknowledge that even *his* method of reckoning distances does not produce such uniform results as the cyclometer.

Of the hundreds of thousands of bicyclists, whether they ride for recreation or from necessity, there is not one who is not interested in the distance he travels, and in the grade and material of the road. To that extent, therefore, all may be said to become students in geography, surveying, and geology. For long rides through unknown territory, road maps and explicit directions are necessary; the grade and quality of the road will determine the time required to complete the journey, while the geological character of the districts traveled will materially affect the condition of the roads during extremely dry weather and after heavy rains. For instance, in a sandy district, after a week of dry weather, bicycling is decidedly hard work; but two hours after a rain the same roads are in the best of condition. On the other hand, a clayey road is slippery, soft, and often unridable, immediately after a rain, but remains as hard as a pavement throughout the dry season. Ordinary loam roads lie between these, being unridable both in rainy and extremely dry weather, but excellent in ordinary weather. All of these may be considered as geological details that are of interest to the wheelman as a surveyor, and important to him as a tourist.

Unfortunately for the traveler, road maps do not, as a rule, give all this information, and far too often they lead the rider off the track by being inaccurate in scale and distance. These inaccuracies are due to errors of different surveyors and draftsmen in making their surveys and plotting their plans, and can be easily corrected if the importance of the work demands it, which, as a rule, it does not. Now, every man who rides a bicycle, and has attached to it a cyclometer that registers the distance traveled, possesses sufficient instruments to measure and lay out a map of the country over which he travels, and thus, should he so desire, to make a surveyor of himself.

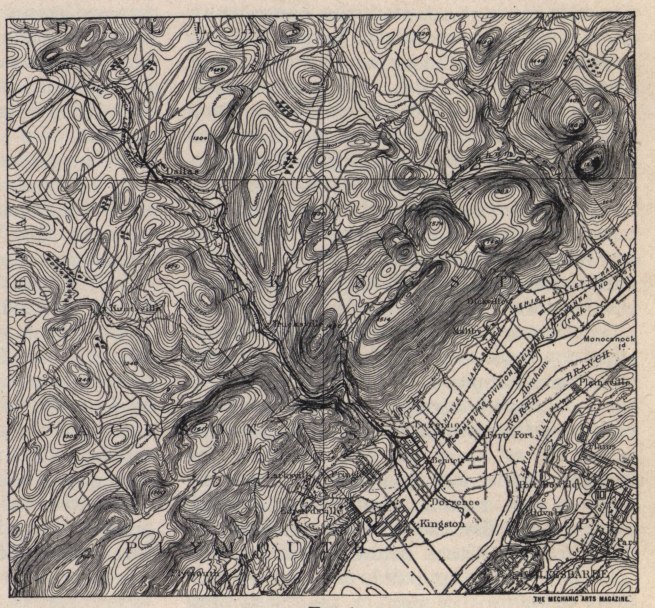


FIG. 1.

True, this map will not be sufficiently accurate to serve as a guide in laying out farm lands, but its distances expressed from town to town will be far more accurate than the traditions preserved among the farmers themselves. Fig. 1 is a map of a portion of Luzerne County, Pa.; it was made from the United States Topographical Survey, and is as accurate as possible in every respect. Such a map, although it costs an enormous sum to produce, and though complete in every detail, is almost useless as a practical road map, because its network of roads and cross-roads and contour lines causes as much confusion as assistance. Besides this, there is no way of telling the number of miles from one place to another without considerable scaling, while information as to the quality of the road is entirely lacking. The chief commendation for this style of map, then, is its accuracy. In Fig. 2 is shown a map of the road from the city of Wilkes-Barre, Pa., to Shawnese Lake, drawn from notes and measurements made with no other instruments than a bicycle and a cyclometer. A comparison of this road between Wilkes-Barre and Dallas, with that shown on the map in Fig. 1, will illustrate the degree of accuracy such a survey may attain; and, for all practical purposes, the map shown in Fig. 2 is just as good and in many ways better than the government survey. Besides, Fig. 2 is more up to date than Fig. 1, as it was made four years after the government survey, and could as a matter of fact be measured, noted, and completed before a survey such as shown in Fig. 1 could be measured around the first square mile.

Now let us consider the method of procedure by which the bicyclist may become a surveyor and thereby able to convert the results of each trip over a new road into a permanent record for future use. In the first place, a word about the cyclometer and its value as a surveying instrument: A cyclometer is not what mathematicians would call an instrument of precision, like the transit, the level, or even the surveyor's compass. It will record with an error of about 1 per cent. when working at its best, and under certain circumstances the error will be increased to 3 per cent. This error is due to the relation between the diameter of the bicycle wheel and the number of revolutions which will cause the cyclometer to record 1 mile. The usual cyclometer, designed for a 28-inch wheel, requires 720 revolutions of the wheel of the bicycle to cause it to record 1 mile; but, owing to the deflation of the tire and the weight of the rider, the wheel may be but 27.5 inches in effective diameter, and the cyclometer will record 1.019 miles for each mile ridden, or 101.9 miles for each 100 miles traveled. In addition to this error, the bicycle actually travels farther than the true length of the road itself, owing to the fact that the rider continually crosses and recrosses the road in

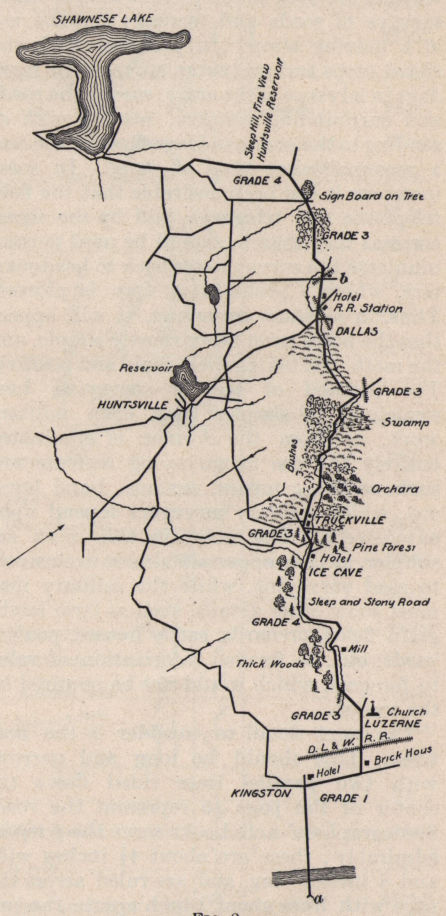


FIG. 2.

order to select the best parts for cycling, and this error, varying as it does according to the character of the road, will amount to about 2 or 3 per cent. more. Therefore, before we start on our survey, we will assume that our cyclometer measurements will all be 5 per cent. in excess of the actual distances traveled. If the bicycle surveyor be an experienced rider, his map may be so plotted that grades and conditions of road may be readily expressed, and other

information never found on the most accurate of maps may be added as a guide to the future traveler.

The method pursued in this work is somewhat similar to that followed by the army in making military surveys. Odometers attached to the wheels of wagons or other vehicles, pedometers carried in the pockets of marching soldiers, and even cyclometers on bicycles are used at the present time to make surveys of roads and territory for the use of a moving army. In practical work the signal corps and surveyors move one or more days in advance of the army, survey the roads and surrounding country, leaving with or sending to the commanding officer in the rear a reconnaissance map of same. In some instances it has been desirable that the field telephone and telegraph, laid by the signal corps as they march, should be used to communicate the survey notes back to headquarters, where a preliminary map is plotted. Thus, in military surveying, it will appear that the notes must be extremely simple, and the method of taking them rapid and positive. The method of bicycle surveying here explained is simpler than even military work, as from the former is eliminated entirely the use of surveying instruments, such as the compass, sextant, hand level, etc., which military surveyors depend upon extensively. The notes in this work are simpler, as they appertain almost exclusively to road surveying, while the military map must show other details, such as farm lands, grain fields, orchards, cattle houses, poultry yards, etc., to furnish information of value to foragers, which would not be required by the tourist.

The next detail to consider is the note book. This should be long and narrow, with two parallel lines ruled down the center of the page to represent the road. Stenographers' note books serve the purpose admirably; these are about 4½ inches wide and 8 inches long, and are ruled across the page with lines about ½ inch apart; the two parallel lines down the center of each page can be ruled with either pencil or pen, and the book is then ready for the trip. A piece of board, the same size as the book, should be secured to the handle bars, and the book laid on and bound fast with rubber bands. A bicycle watch on the handle bar is also a great convenience, but by no means a necessity.

The arrangement will now look somewhat as in Fig. 3. At *a* is the cyclometer, the record of which should be easily read by leaning over the handle bars; at *b* is the note book, and at *c* is the watch, which will act as a check on the cyclometer and grade notes. Now, we will assume that the bicyclist is out on a trip with a number of other enthusiasts, and, therefore, will be unable to stop and make any individual measurements of the roads and landmarks which he passes. All notes must be made awheel, and information recorded without slackening speed. Before he starts, the register of the cyclometer is observed, and written on the lowest line of the note book and is found to be 2,388.8 miles, as shown

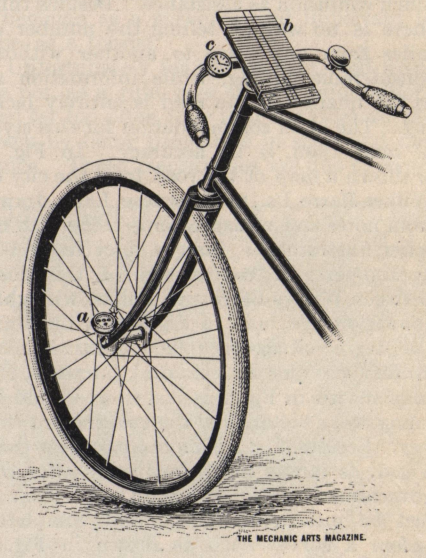


FIG. 3.

in Fig. 4. In recording subsequent cyclometer readings it will not be necessary to note the thousands and hundreds of miles, except when these figures change.

The surveyor starts out through the main street of Wilkes-Barre, and as he crosses the river he notes that his cyclometer reads 2,389.05 miles, and on the second line from the bottom he marks this record, as shown in Fig. 4, and at the same time draws two wavy lines across the road to indicate that it was while crossing the river that he recorded this reading. Soon he arrives at the Kingston cross-roads, and there turns to the right; his cyclometer reading is recorded as 90.24, and, branching from the right of the central column of his note book, he indicates the road he takes with an arrowhead as shown, while on the left he shows a similar cross-road with no arrow. Observe, also, that his note book does not show this cross-road as

branching at a right angle from the road he is traveling, but is drawn according to his judgment, at *about* the angle it actually makes. On the opposite side of the road, on the corner, is an old tavern, and he marks a rectangle to indicate it in his notes as shown. Village streets branch from the main road through Kingston, and these he indicates as he passes as shown in the notes at cyclometer readings 90.39 and 90.44. At 90.99 he arrives at the village of Dorrance, takes the left branch, and rides straightaway to 91.85—in the village of Luzerne—where he takes the left branch for a little way and then at 92.25 the road itself turns slightly to the right.

This indication of a bend in the road is made simply by drawing, in the central column, two straight lines, intersecting at about the angle of the bend of the road, as shown in Fig. 4. In general practice, slight bends in either direction are not considered; but, where a bend or a branch of the road is but a trifle less or a trifle more than a right angle, this shortage or excess should be indicated by a plus or minus sign, as shown on the branches at Kingston and Dorrance 90.24 and 90.99. At 92.70 the road bends to the left, and at 92.80 it turns to the right, while at 93 it turns at right angles as indicated. At 94.15 the road forks, and the tourist takes the right fork, as indicated by the arrow. Soon he crosses a stream, as indicated by the wavy line at 94.58, and $\frac{2}{10}$ of a mile beyond he passes through Truckville, and takes the right fork of the road out of that village. At 96.72 there is a branch road back and to the left, which the rider takes. At 97.93 there is a similar branch road to the left, and at 98.10 there is a branch road to the right in the village of Dallas.

We have only considered here the distances and the roads, while on the left of the note book are a number of entries of landmarks that give additional value to the directions when used by some one else than the original surveyor. The cross-hatched line at 92.25 indicates that there is a railroad crossing there. At Mill Hollow is shown a small rectangle to the right of the road, while marginal notes on the left of the page indicate what stands in the place so marked. The time of arrival at and departure from different places, as marked on the left of the page, is also of value, as showing the general character of the roads traversed. For instance, from Wilkes-Barre to Kingston, a distance of $1\frac{1}{2}$ miles, covered in 7 minutes, indicates a good piece of fairly level road, and the same may be said of the stretch

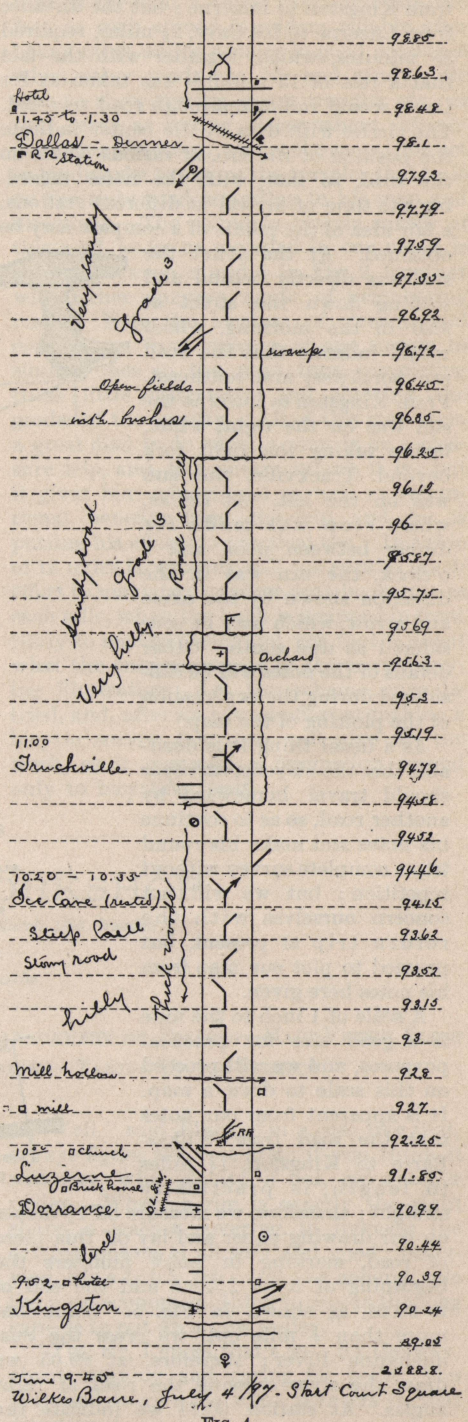


FIG. 4.

from Kingston to Luzerne; but the distance from Luzerne to Ice Cave, 2⅔ miles, required 35 minutes, which, together with the fact that a rest of 15 minutes was taken at Ice Cave, would indicate a rough road traveled. The circles with dots in the center indicate the position of the sun, at various points on the road, so that, with the notes regarding the time of arrival at different stations, a fair idea of the points of a compass may be obtained. At the start the sun was directly behind and shining down the street at 9:30 in the morning, which would indicate that the road ran northwest and southeast. From Kingston to Luzerne the sun was on the right, while, before taking the right fork beyond Truckville, the sun was on the left. At Dallas, where stop was made for dinner between noon and 1 o'clock, the sun was in the direction shown by the circle and arrow, which may be considered as due south. Other details of the notes will be considered during the explanation of the plotting of the map.

As a usual thing it is desirable that the bicyclist surveyor should travel homeward by another road, so as to continue his notes and make his round trip a complete survey without repetition; but we will not concern ourselves with the return trip at present, but proceed to plot our map from his notes here given.

A scale of 1 inch to the mile is a good size for practical purposes, and we will proceed on this scale to draw a map. It is apparent from our notes that the road from Wilkes-Barre to Kingston, 1½ miles in length, is practically straight; therefore, we measure off 1½ inches on our drawing paper and lay off this piece of road, marking in small numbers the beginning of it as 2,388.8 and the end of it 90.24, as shown in Fig. 5. Somewhat more than ⅛ mile out, we cross the Susquehanna River; therefore, at 89.05 we draw the river crossing the road at right angles. At station 90.24 we indicate the road branching to the right and left, and continue the right branch until it measures 3 miles from the beginning. This takes us to the village of Dorrance, which is marked in our notes as 90.99, where we turn to the left at an angle slightly in excess of a right angle, as indicated by the plus mark, and plot our road to 91.85; here the road forks to the left, and we continue through Mill Hollow, a small settlement that evidently takes its name from an old mill on the right of the road, as indicated by the notes. Here the road crosses a small stream, turns to the right, and at station 93 takes a sharp turn at right angles to the left, which, with a subsequent half turn to the left, and two half turns to the right, brings us to another small settlement called Ice Cave, 94.15. About 2 miles from here, after crossing a small creek, we arrive at Truckville, indicating the creek by a wavy line, and then plot the road to Dallas. The creek may now be continued parallel to and on the right side of the road and up to 95.63, where it crosses the road to the left side, but recrosses and returns almost immediately. When the cross-road at Dallas is plotted, particular attention must be given to its direction, as, according to the indicated position of the sun in the notes, this road should run north and south, and any errors in the previous lines should here be corrected.

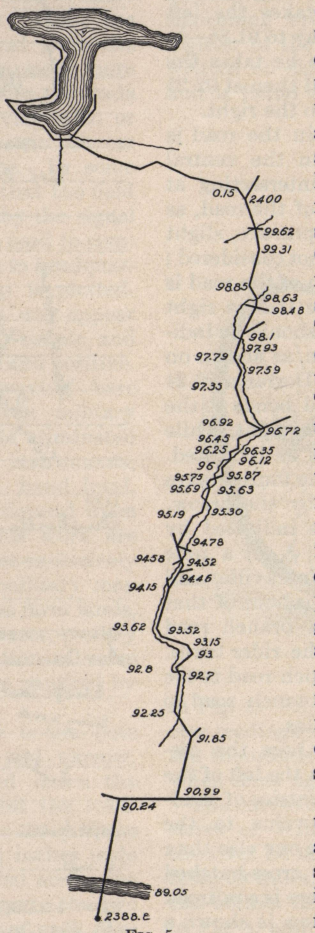


FIG. 5.

The rest of the road up to the lake is similarly plotted and the road around the lake sketched in; then the lake itself may be drawn, as the road extends along its border and is governed largely by the outline of the lake itself. Thus, a complete and satisfactory survey of the road may be plotted in an hour, from notes which were taken without the slightest loss of time on the trip. Subsequent trips and similar surveys of other roads in the vicinity, when plotted, will be found to fit in one with another, and thereby make a most satisfactory map, as shown in Fig. 2. The bicyclist is rendered more observing by work of this

character, he sees every detail, he notes every bend in the road, and in a short time he unconsciously searches for some landmark by which he can identify a certain piece of road, either for his own or some one else's use. In making notes on a trip, it is always wise to assume a certain definite angle which will indicate a bend in the road.

Where a road crosses or changes its direction at right angles to the course pursued by the rider, the record is not difficult; and even where the deviation or crossing is at an angle of 45°, there is little chance of error; but for angles between these it requires a trained eye to judge them with accuracy, and they should be recorded as 45° or 90° turns, according to which they are nearer to; but a slight deviation from a right angle should be indicated where such exists, and a plus or minus sign marked, in order that the figures may plot more satisfactorily. Always note everything possible. On a road map, a landmark is often more important than roadbed or distances. At every cross-road, fork, or abrupt turn, identify a landmark. This may consist of an "old tree," a "church," a "red barn," a "stone mill," or any object which may in a few words be described as a monument to locate a particular point in the survey. Always show streams of water when they run parallel to or across the road, and indicate which way they flow, for such details give information as to the grade. Where a road is through a thick wood, indicate the fact, as such a road is seldom ridable after heavy rains, and is usually in good condition when other roads are dry and sandy. Be sure to show springs, water troughs, etc., as they serve as resting places where refreshments may be taken, and at the same time act as landmarks to assure the traveler that he is on the right road according to his map and directions. The complete bicycle survey of this road, as far as recorded in our notes, is shown between *a* and *b* in Fig. 2, together with other surveys made of neighboring roads. Note the location of streams and connections from streams of one survey to similar ones in the next, thus completing these little waterways and showing the grades of the locality. All of this may seem a great deal to do when a man is on a pleasure trip, and, to a certain extent, it is; but it gives him educational as well as recreational benefits from the trip, and he is putting his efforts to practical use. In a ride of 18 miles it certainly will not require much effort to make two or three note-book entries each mile, when the book is strapped in front ready to receive them, and yet that is about what the entries average in the accompanying illustration. Let the scheme once be tried, and, after an honest effort at making a bicycle survey, few men will give up the work, as it possesses a fascination second only to bicycling itself.

IN THE WORKSHOP.

(*Continued from the March, 1899, Number.*)

H. Rolfe.

REMEDIES FOR A SLIPPING BELT—CARE AND MANAGEMENT OF BELTING—HAIR VERSUS FLESH SIDE OF LEATHER—UNSTEADY RUNNING—TAKING UP FOR STRETCH.

"WE WERE talking the other day," said Tom (continuing the conversation recorded in our last), "about wrought-iron pulleys whose rims were in bad shape. I should think that, where a rim was hollow or where its diameter was greater on one side than on the other, the pulley might be made serviceable by gluing around it a piece of leather, of such width and thickness as to correct the error in the rim itself; after the glue has set, the leather could be pared down so as to have the proper profile."

"Well," said Blunt, "in a case like that, always figure the cost first; if you think it will pay, why, do it; if not, get another pulley. Where a rim is exactly the right shape, a leather covering, to increase the driving power, is all well and good; otherwise, it's a botch job; and as a general rule the most economical thing to do—in the long run—is to put up a new pulley."

"Yes, sir, I guess that's so. By the way, about cleaning and caring for belts: you promised to give me some pointers in that direction."

"Well, I'm glad to see you haven't forgotten it, for there's lamentable waste in some shops through neglect in that direction. A belt, after being in use for a time, acquires a hard, smooth surface. Then, naturally, it begins to slip, which makes the surface worse. Then the man in charge tightens it up. The improvement, if there is any, is only temporary; so, very soon, more tightening is resorted to. But this tightening of the belt means more pull on the bearings—both when working and also when running on the loose pulley, and this means a waste of power and oil—an especially unnecessary waste when the belt is on the loose pulley; it would be a good thing, in fact, if the tension could then be released altogether."

"Why not make the loose pulley a trifle smaller in diameter than the fast one?"

"Well," said Blunt, "as a matter of fact, that is done on some jobs. You will find an instance on the traveling crane in the erecting shop. The belt pulleys for traveling, cross-traversing, and hoisting are arranged in that way. The loose pulleys are all 16 inches in diameter; while the belt is on one of them, it is comparatively slack; the fast pulleys are 16¼ inches in diameter, and are beveled down on the inner edge, so that the belt shifter has no difficulty in sliding the belt on to the larger pulley, where it immediately becomes taut enough to take hold of its load."

"But don't you think it's a bad thing for the belt itself to vary the strain on it in that way? Wouldn't it last longer if kept at the same tension all the time? Take the case of a fiddle string: it doesn't do to let *that* down every time you stop playing. I happen to know that, because my brother, who tortures the catgut under the impression that he's making music, used to slack his E string down before putting the instrument away for the night, and soon found that the next time he played he was sure to have trouble trying to keep that string up to concert pitch. The only way to make it hold its note was to keep it right up to pitch *all* the time."

"That may be so," said Blunt, "but a fiddle string isn't a leather belt; we don't want to keep a belt in *tune;* the object is to make it *last* as long as possible, and I'll bet dollars to doughnuts that a leather belt will last longer if slacked off when not in use. This might or might not be so if there was merely a straight pull throughout the length of the belt; it is the continual bending and unbending around the pulley that wears the belt out, and the less the pull the less this bending effect; in any case, however, there is a saving in oil, and less wear on the bearings. But we are getting away from the subject. I was speaking of the very bad practice of continually tightening up a belt to make it do its work. Now, instead of doing this, you should take the belt *itself* in hand, and restore its proper surface. Any belt, after being in use for a certain length of time, will get smooth and hard. Wait till shutting-down time on Saturday afternoon; then wash the belt well. Use warm water, with a little soda, and let it soak well into the surface of the belt. You'll find that the dirt and stuff will come off readily enough, and leave the surface of the belt clean. Let it dry thoroughly, and on Monday morning, before starting up again, give it a good coat of dubbing. Belts that run in warm places, such as engine rooms, will naturally get dry sooner than others, and will be all the better for a coat of dubbing every three or four months. Dubbing to a dry belt is like water to a parched soil.

Sometimes you are bothered with *oil* on a belt; maybe the cup on a loose pulley leaks and lets the oil down the arms on to the rim; or it works out of a bearing and travels along the shaft and so reaches the pulley. Dynamo tenders could weep with you on this score. A dose of powdered chalk will mend matters; don't put it on with a shovel, though; keep it in a tin can that has half a dozen holes punched in the lid.

"It always pays to look after belts, especially those that have continuous hard work to do. About every eight or nine months, give every belt a coating of dubbing, and then put on two or three coats of boiled linseed oil. The dubbing preserves the leather, and keeps it soft and pliable; the oil oxidizes and forms a gummy surface on the belt—a sticky, clammy surface which holds on to the pulley in great shape. You can easily picture to yourself how such a surface lies down upon and clings to the face of the pulley, coming in close contact everywhere, like a boy's leather sucker on a brick."

"Talking of surfaces, what is your opinion, sir, about running the belt with its hair side against the pulley, instead of the flesh side?"

"Well," said Blunt, "it always seems to me wrong to run the hair, or grain, side next to the pulley. It's working against nature. If you take a piece of leather and bend it first one way and then the other, you will find that it bends much more easily when the flesh side is inwards, and it is perfectly

natural that it should, too, for that is how it had to bend when it was on the cow. No, I'm talking seriously. Take a thin strip of leather, and stretch it forcibly; then lay it down on the bench and watch it; soon you will see it begin to curl up with the flesh side inwards. All this points to the propriety of running the flesh side next the pulley, so that the continual bending shall be in the direction that is natural to the leather itself."

"That seems plausible enough," said Tom, "but I've heard that the driving power is greatest with the hair side next the pulley—as much as 30 per cent. more, some say."

"Well, perhaps so, but I can't see where the extra holding power of the hair side comes in, unless, being smoother and more even, the contact is more perfect. But the tensile strength of the belt is reduced by bending it against the grain. Then again, by a proper use of dubbing and boiled linseed oil, as already explained, the flesh side can be very much improved; the treatment 'kinder' fills up the cracks and uneven places, and produces an A-1 surface. Anyway, whatever else you may do, keep the resin keg under lock and key and have a savage dog alongside to guard it."

"All right, sir," said Tom, laughing at his foreman's emphatic utterance. "By the way," he went on, "I was in the North works the other night—they were working overtime—and I noticed that the main driving belt in the turnery ran very unsteadily; the slack side had a kind of wavy motion, up and down. What do you suppose caused it to run like that?"

"Well," said Blunt, "there are, in the main, two things that will cause it: the engine doing irregular work; and the off-take of power from the driven shaft being uneven. We'll take the engine first: If one side of the piston is getting more steam than the other, *impulses* will be generated that will give the flywheel an uneven speed—unless the wheel is heavy enough to counteract the tendency—and this 'snatching' action will be communicated to the main shaft, and so cause the belt to undulate on the slack side, and sometimes, if severe enough, on the tight side too.

"Then, with regard to the driven shaft, if this is belted up to a machine that takes the power off at successive intervals instead of continuously—as, for instance, when driving a circular cold saw where the saw is out of true and cuts during only a part of each revolution—the belt will soon begin to undulate, and the only way to prevent it is to true up the saw."

"I see. But with regard to the engine, why is one end of the cylinder allowed to do more work than the other?"

"It shouldn't be. But getting more steam doesn't necessarily mean doing more work, unless it's the front end of the cylinder that gets it. You see, the crank-side of the piston has less effective area than the front, owing to the presence of the piston rod. Now, by an unhappy coincidence, it is this very side that gets the least steam, owing to the fact that the action of the connecting and eccentric rods effects an earlier cut-off at the crank-end, the piston's motion being slower and the valve's quicker than at the front end. This can be, and of course is, remedied by the valve setter; in fact I always used to give a little more steam at the crank end to make up for the piston rod's being there—a proceeding doubly necessary in a vertical engine, where the moving parts have to be lifted every time.

"But there is still another thing that will cause a belt to undulate, and that is an unbalanced pulley. A pulley should be perfectly balanced before it is put up, otherwise, in attempting to rotate around its own center of gravity, it will cause the shaft to wabble and the belt to run unsteadily."

"How about the stretch of belts, sir? Our belt tender says that it doesn't matter who you get them from, they all need frequent taking up for the first month or two."

"Yes," said Blunt, "they're all alike in that respect. A leather belt that won't stretch is about as great a rarity as an all-wool shirt that won't shrink. The fact is, the only way to stretch a belt is to run it on pulleys and do work with it; so, whatever the makers may say about the belt being 'non-stretchable,' you must expect to have to take it up after two or three days' running, and then at intervals for the next few months. Link belts are particularly bad offenders in this respect; you see, every one of the numerous pins 'sets' a little in its link, under the pull, the aggregate amount being considerable. In an 80-foot link belt, you will be lucky if, during the first two weeks, you don't have to take out at least a foot of stretch. There's one thing, though, it's easier to shorten a link belt than an ordinary one, which again goes to prove that 'there's a bright side to everything,' even to a leather belt."

(*To be Continued.*)

SLIDING FRICTION.

G. Herbert Follows.

A Consideration of the Well-Known Laws Which Govern Resistance Due to Sliding Friction—How to Use a Coefficient of Friction.

PRESS together the palms of your hands, then try to slide one palm over the other. You find that before sliding begins you have to overcome a resistance, and that the more forcibly you press them together the greater the resistance is. As every one knows, this resistance is called *friction*. To distinguish this particular kind of friction from others—such as *rolling* friction—it is called *sliding* friction.

The purpose of this article is to point out in a practical manner the influence that sliding friction has on the design and efficiency of machinery.

There are few books on machine design that do not describe some kind of winch, or crab, as an example in leverage. Fig. 1 is taken from a well-known textbook in which it is explained that the leverage obtained by the combination of crank, gears, and drum shown is 150, and that, therefore, "neglecting friction," a force of 10 pounds applied at the crank will raise a load of 1,500 pounds suspended from the hook. Now this is quite true, and, as an example of what leverage does for us in machinery, it is excellent. Unfortunately, however, many beginners find this part of their studies far too easy, and pass over, as of but slight importance, that little clause "neglecting friction." Later on, they read that friction varies directly as the pressure between, and is independent of the areas of, the surfaces in contact, and so on—getting possibly a fair idea of what a *coefficient* of friction is, and then passing on to other studies.

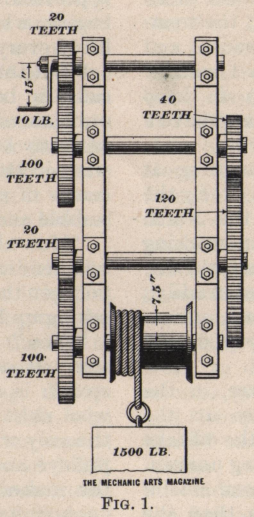


FIG. 1.

But the time comes when the young student is engaged as a draftsman, and is asked to "put some figures" on, say, a hoisting mechanism. Then he refers with feelings of diffidence to his Nystrom, Haswell, Trautwine, or Kent, for a coefficient of friction; and then—to use a little slang, he gets "all balled up." Some of the figures that have been put on hoisting mechanisms are truly wonderful in their simplicity. Here is a favorite way of calculating the lifting capacity of the winch shown in Fig. 1. Neglecting friction, 10 pounds at the crank-handle will raise 1,500 at the hook; coefficient of friction for steel on cast iron—taken from a table in one of the note books aforesaid—.10; loss by friction, $1,500 \times .10 = 150$ pounds; actual lifting capacity, $1,500 - 150 = 1,350$ pounds; whereas, in all probability, 10 pounds at the crank-handle will not raise more than 1,000 pounds. But we shall return to this problem later; there are many things we must understand before we can hope to solve the problem correctly.

First of all it is necessary to know just what the laws already referred to mean; because, although the laws, as stated, are true, they are frequently misunderstood and misapplied. Here, a few very simple experiments will help: In Fig. 2, a is a cast-iron block; p is a cord, by means of which, and through the spring balance s, the block may be dragged about over the cast-iron surface m. The weight of a is 10 pounds, and the condition of the surfaces in contact is supposed to be such that a force of 1 pound—as indicated by the spring balance—is just enough to overcome the frictional resistance and thus to move the block in the direction of the pull.

In Fig. 3, there is the same apparatus, but a block b, also weighing 10 pounds, has been placed on top of a; it is now found that a force of 2 pounds is just enough to move the blocks. Thus, doubling the pressure between the surfaces in contact doubles the frictional resistance. In Fig. 4, another 10-pound block has been added, and, as indicated by the spring balance, the frictional resistance then becomes 3 pounds. In

other words, trebling the pressure between the surfaces trebles the frictional resistance. This direct relation between the pressure and the friction is the meaning of the first of the laws under consideration, which is: *Friction varies directly as the pressure between the surfaces in contact.*

The second law is: *Friction is independent of the areas of the surfaces in contact.* A misapprehension of what this law means has led many a good draftsman into trouble, and the reader is therefore asked to follow with care what is said about it.

When describing the experiments represented in Figs. 2, 3, and 4, no mention was made of the area of the surfaces in contact; this was because the point then under consideration had to do merely with pressure and resistance. Throughout the experiments, the block remained resting upon its two narrow feet, and evidently the size of these feet had nothing whatever to do with the three results obtained. But suppose we turn the block over, so that it rests on its large flat surface, as in Fig. 5; what then? Well, if the smoothness of the large surface now in contact with m is exactly the same as the smoothness of the two feet, the force required to move the block will be precisely the same as it was before. And that is what the second law means; but we have not finished with it yet. Before going further, however, something had better be said about *coefficients.*

A coefficient of friction is the ratio between a frictional resistance and the pressure that causes it. Thus, in the first experiment the resistance is 1 pound; the pressure that causes it is 10 pounds, and the coefficient is $\frac{1}{10} = .10$; in the second experiment (the surfaces in contact being the same, the coefficient should be the same), the resistance is 2 pounds; the pressure that causes it is 20 pounds, and the coefficient is $\frac{2}{20} = .10$, as before. A coefficient is used in the following manner: If the pressure between two surfaces is 500 pounds, and we know that for those surfaces the coefficient of friction is .07, we ascertain the frictional resistance by multiplying the pressure by the coefficient, and we get $500 \times .07 = 35$ pounds. Coefficients of friction are found by experiment, and cannot be determined in any other way.

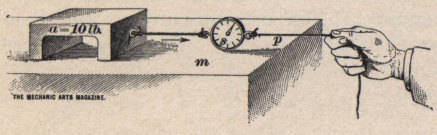


FIG. 2.

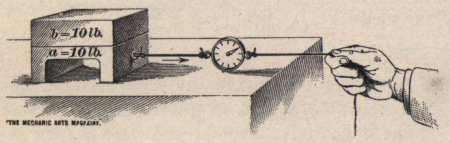


FIG. 3.

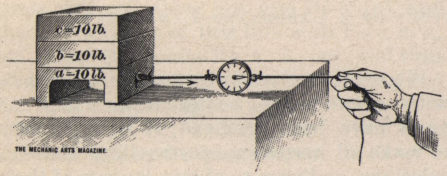


FIG. 4.

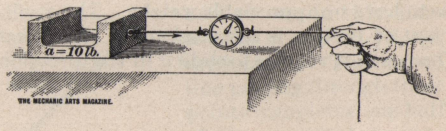


FIG. 5.

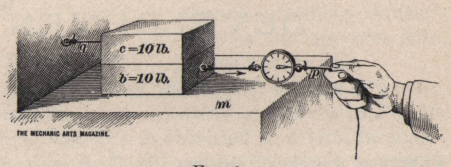


FIG. 6.

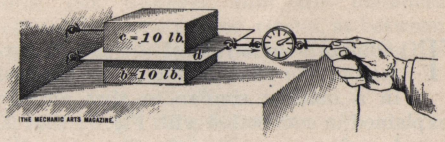


FIG. 7.

To return, now, to the second law: An experiment with the 10-pound blocks b and c is represented in Fig. 6; the pulling cord is attached to b, and c is placed on top of b; but c is restrained, in the manner shown, so that it cannot move in the direction of the pull on b. The condition of the surfaces in contact is supposed to be the same as before; the coefficient of friction, then, is .10. Bearing the second law in mind, what fractional resistance will there be? Well, it might at first sight be supposed that, as the total pressure on m is 20 pounds, the resistance would be $20 \times .10 = 2$ pounds. But the spring balance indicates 3 pounds; and it is right, for the following reason: There are two distinct and separate resistances, because there are two distinct and separate pairs of surfaces in contact, namely, bottom surface

of b with m, and top surface of b with c. Between the first of these pairs, b and m, there is a pressure of 20 pounds; this pressure produces a resistance of $20 \times .10 = 2$ pounds. Between the second pair, b and c, there is a pressure of 10 pounds, which produces a resistance of $10 \times .10 = 1$ pound. It is the sum of these two amounts that constitutes the total resistance, and this equals $2 + 1 = 3$ pounds, which agrees with the spring balance. In Fig. 7 a similar but still more striking experiment is illustrated. There are the same 10-pound blocks b and c, both of which, however, are prevented from moving in the direction of the pull; between them is a sheet of tin d, supposedly so thin as to have no appreciable weight. The coefficient of friction is again taken at .10. What force will it require to slide d in the direction of the pull? It might at first be supposed that, as the pressure between b and c is but 10 pounds, the resistance would be $10 \times .10 = 1$ pound; but the spring balance indicates 2 pounds, before the sheet of tin begins to move. The explanation is the same as before. There are two separate pairs of surfaces in contact, namely, top of d with bottom of c, and bottom of d with top of b. Between each of these pairs there is a pressure of 10 pounds, thus producing two separate resistances of 1 pound each, or a total resistance of 2 pounds.

This *multiplication* of the *pairs* of surfaces in contact must on no account be confused with the *areas* of the surfaces that *are* in contact; the experiments already performed prove that they are two very different things.

(To be Concluded.)

DEVELOPMENTS, OR LAYOUTS.

(Continued from March, 1899, Number.)

D. C. Reusch.

FURTHER APPLICATIONS OF THE PRINCIPLE OF ROLLING, WHEN MAKING LAYOUTS OF CURVED SURFACES—THE ACTUAL GEOMETRICAL LAYOUT OF A CARDBOARD LAMP SHADE.

TO OBTAIN the layout of the curved surface of the cone in Fig. 7, we proceed in a manner similar to that already explained in connection with Fig. 5; that is, we place the cone so that the diameter $a\,b$ is vertical, and imagine it rolled until the other end of the diameter reaches the paper. It is evident that, while rolling, the cone describes part of a circle around the center c; the

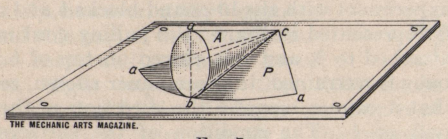


FIG. 7.

dimensions of the surface thus rolled over are easily obtained; with radius $a\,c$ or $b\,c$, draw upon the paper a circular arc $b\,a$, and make the length of it equal to half the circumference of the base of the cone; then draw straight lines from the ends of this arc to the center c. The surface thus outlined is the layout of one-half of the curved surface of the cone, and the other half is obtained by simply repeating the operation on the opposite side of the center line $b\,c$.

We see then that, so long as we have to do with symmetrical bodies from which no parts have been removed, it is quite easy to make all necessary constructions and calculations, and thus to obtain layouts of their surfaces. But when a body is no longer symmetrical, when certain parts of it have been cut away, the necessary constructions seem rather difficult. In reality, however, they are quite as simple—though, it is true, a little more extended than before—and if the principles explained in reference to Fig. 6 are fully understood, no serious difficulty will be experienced.

In Fig. 8 we have an example of this kind—a cylindrical pipe from which certain parts have been cut away, the openings left being clearly marked $a\,b\,b_1\,a_1$ and $a_2\,b_2\,b_3\,a_3$ in (c). As shown at (b), the distances $a\,a_1$, $a_1\,a_2$, $a_2\,a_3$, and $a_3\,a_4$ are all alike, being each equal to one-eighth of the circumference of the pipe. To make the layout, we proceed at first as if the pipe were complete, and find the points a and c on the paper which the cylinder, if rolled, would mark out. Then we draw lines $P\,a_1\,c_1$, $a_2\,c_2$, etc. at distances apart equal to those on the cylinder. (The

reader will here note that when, in what follows, a measurement or string of measurements is prefixed by the letter P, as in the last sentence, it means "on the paper"; similarly, when a measurement is prefixed by A, it means "on the body." This will save the constant repetition of explanatory clauses.) Referring to Fig. 8 (*a*), the lines $b\,b_1$ and $b_2\,b_3$, being in line with each other, constitute parts of the circle $b\,b_4$; and this circle will roll along the line P $b\,b_4$ (*c*), and the intersections of this line with P $a\,c$, $a_1\,c_1$, etc. locate the points P b, b_1, b_2, etc., and thus give the outlines of the openings P $a\,b\,b_1\,a_1$ and $a_2\,b_2\,b_3\,a_3$, completing the layout.

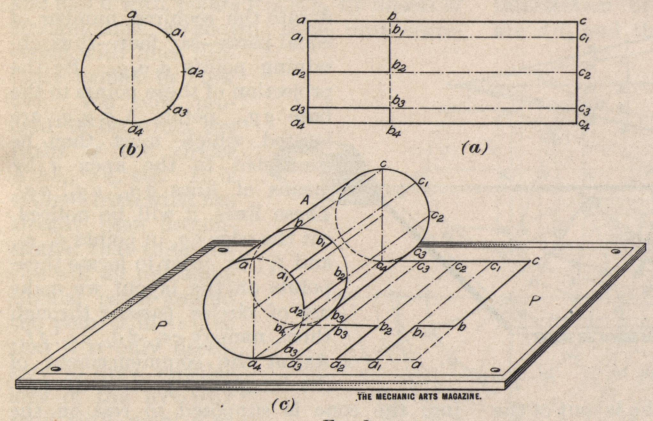


FIG. 8.

In Fig. 9, at (*a*) and (*c*), are shown a side and a perspective view of a piece of pipe that is intended to be joined at right angles to a similiar one. It is desired to outline a pattern from which a pipe of this form and size may be made; to do this we again use the principles explained with reference to Fig. 6. We select a certain number of equidistant points around the slanting end $b\,f_4$, and find the position of these points on the plane of the paper over which the pipe is supposed to roll; this is done in the following manner: Describe, as at (*b*), a circle representing the end view of the pipe; divide this into any convenient number of equal parts—say eight—and project the points of division to the slanting end of the cylinder, as shown in (*b*), thus obtaining the lines $a\,f$, $a_1 f_1$, $a_2\,f_2$, etc., cutting the edge $b_4\,f_4$ at certain points $b\,c_1\,d_2\,e_3 f_4$. Proceeding now as if the pipe were complete: If, through each of these points, we imagine a circle, as $b\,b_4$, $c\,c_4$, etc., and then imagine the pipe rolled over the paper as before, these circles will imprint on the paper lines $b\,b_4$, $c\,c_4$, etc., as shown at (*c*); then all that remains to be found is the location of the points in question on these lines. The point A b in (*c*) can lie nowhere else than at b on line P $a\,f$; point A c_1, being the point of intersection of line A $a_1 f_1$ and circle $c\,c_4$, must also be the point of intersection of P $a_1 f_1$ and P $c\,c_4$, and so on; in this manner the points P $b\,c_1\,d_2\,e_3 f_4$ are located. The curved line passing through these points completes one-half of the required layout; the other half is a counterpart on the opposite side of the center line.

The layout of the curved surface of a cone that has been cut away as shown in Fig. 10 at (*a*) and (*c*), is obtained in a similar manner, and it should not be necessary to repeat the explanations. It is perhaps as well to point out, however, that the distances between the construction circles, as between $a\,a_4$ and $c\,c_4$, in (*a*), must be measured along the slanting surface, and not along the axis; the reason for this is evident. If the cone rests with line $b\,e_4$ in contact with the paper, the distances along this line only should be considered; confusion is thus avoided. The distance P $a\,c$ between the circular curves P $a\,a_4$ and $c\,c_4$ must therefore correspond

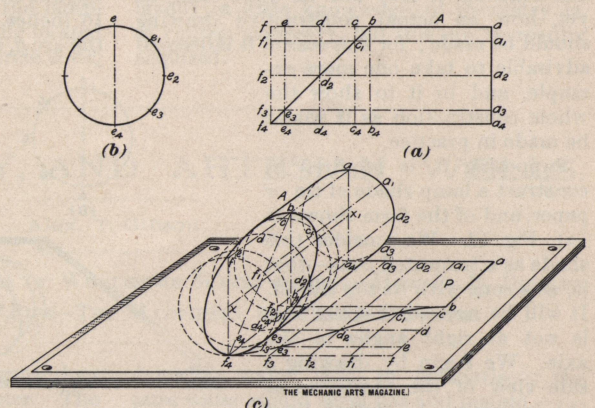


FIG. 9.

with A $a_4 c_4$ of (a) and not with $a_2 c_2$. In other respects, Fig. 10 is self-explanatory.

In Fig. 11 is shown the construction by which the layout of the curved surface of a cone with a slanting base is obtained. The reader should find no difficulty in following the method employed; the only practical

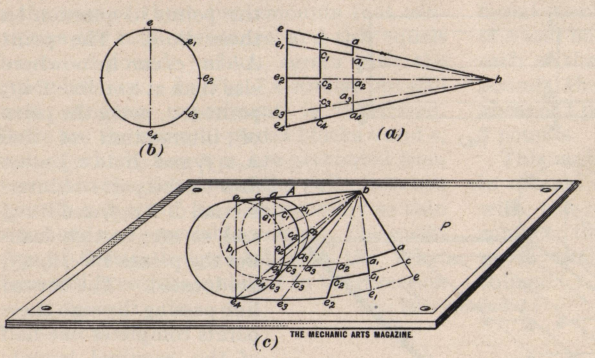


FIG. 10.

difference between this and the layout of the pipe of Fig. 9 is that with the cone the construction circles roll along circular arcs P $a a_4$, etc., instead of along straight lines.

So far, the various layouts and constructions described have been illustrated with the aid of perspective drawings, the idea having been to represent the subject in a manner intelligible to all. To those who are not familiar with both perspective and mechanical drawing, it may not be quite clear, as yet, how an actual constructive drawing should be made; for this reason it is deemed advisable to take one more example, and in it to show the whole construction as it would be made in practice.

Supposing it is required to construct a lamp shade of tin or paper, and of the form shown at (a), Fig. 12. We consider this shade as a truncated cone—that is, as a cone with its top cut off. It will be noticed that the base is not at right angles to the axis. We begin by drawing a side view of the shade, as at (b), indicating by dotted lines the outline of the complete cone, and ascertaining by actual measurement the dimensions that, in addition to those given, are required to make the layout.

In previous examples we have in every case drawn a complete end view of the solid under consideration; in actual constructive work this is not absolutely necessary; a half-end view is sufficient, its sole purpose being to enable the draftsman to locate, by projection upon the side view, lines dividing the surface to be developed into the required number of equal or proportional parts. In the present case, then, we describe a semicircle on the base of the cone and divide it into the required number of equal parts—say four—thus obtaining points $g_1 g_2 g_3$. By the projection of these points to the base $g g_4$, points A $g_1 g_2 g_3$ are located, which must then be connected to the apex a by means of lines $a g_1$, $a g_2$, $a g_3$. These lines, it will be noticed, cut the edge $c g_4$ in points d_1, e_2, and f_3; in order to locate these points on the layout we make use of circles passing through them, namely $c c_4$, $d d_4$, $e e_4$, $f f_4$. As, at the commencement of the imaginary process of rolling, the cone is supposed to rest on the line $a b_4 g_4$, the correct distances between these circles must be measured upon this line. The actual layout is shown at (c), Fig. 12, and it is made in the following manner: Draw a vertical line $a a_2$—a line in any other direction would, of course, answer the purpose, but when drawing with instruments it is best to make a center line either vertical or horizontal—and set off upon it the length of the side A $a g_4$, namely 16 inches. Then, with compasses, describe the arc $g_4 a_2$; this arc, being the path of the

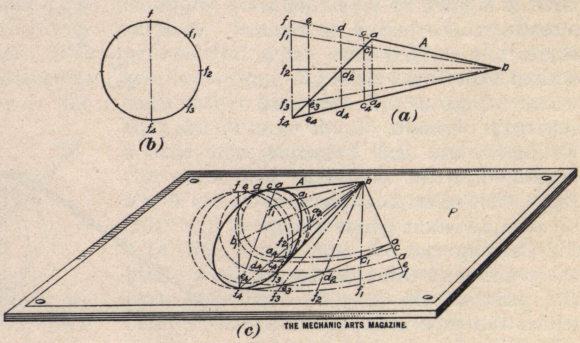


FIG. 11.

circle A $g g_4$, marks the extreme limit of the conical surface. As the cone is supposed to have made half a revolution by the time the point A g reaches the paper, the length P $g g_4$ must equal half the circumference of the circle A $g g_4$, or $\frac{16 \times 3.1416}{2} = 25.13$

inches; this length, then, must be measured along the arc $g_4 a_2$, thus locating the point P g; joining $a g$, we obtain the limiting edge. Now divide the arc P $g g_4$ into the same number of equal parts as at the beginning we divided the half circle $g g_4$ in view (b), and join a with points P $g_1 g_2 g_3$ by means of straight lines, as shown; these lines correspond with lines similarly named in view (b). We now proceed to construct the paths of the circles A $b b_4$, $c c_4$, etc. It is evident from what has already been demonstrated that these circles will all roll along circular paths around the point a in (c), so that it is only necessary to draw circular arcs of the proper radii with point a as center. The circle A $b b_4$ will roll along a circular arc of 4 inches radius, which arc, therefore, in (c), outlines the upper edge P $b b_4$. The other radii may be taken direct from view (b), and thus the arcs P $c c_4$, $d d_4$, $e e_4$, $f f_4$, in view (c), obtained.

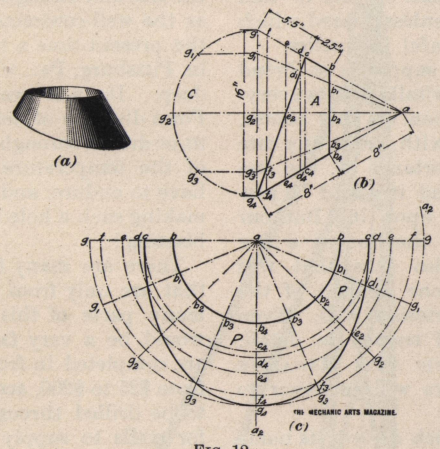


FIG. 12.

We have now done all that is necessary to enable us to outline one-half of the lampshade layout; thus, point A c, being located in line A $a g$, and also upon the circle A $c c_4$ [see view (b)], must lie on corresponding lines in view (c), and must therefore be the point where these lines intersect, namely P c; point A d_1 in (a) is on the circle $d d_4$ where it is intersected by the line $a g_1$; therefore, on the layout it is the point of intersection of the corresponding circular arc $d d_4$ and the line $a g_1$, in other words, at d_1; in a similar manner, the two remaining points e_2 and f_3 are located. The curved line passing through these points, namely the line $c d_1 e_2 f_3 g_4$, completes the layout of one-half of the shade, and when this is repeated on the other side of the center line $a a_2$, the complete layout has been made.

Other examples might be given, to show that the principles laid down in the first part of this article are applicable in a general way, but enough has perhaps been said to prove that the man who thoroughly grasps the idea of unrolling the surface to be developed is in a position to make any ordinary workshop layout; a little knowledge of geometry is, of course, necessary, but this can be readily acquired.

WATER SUPPLY, AND ARTESIAN WELLS.

Alex. T. Gibson.

THE ARTESIAN WELL AS A SOURCE OF WHOLESOME WATER SUPPLY—HOW IT IS DRILLED AND LINED WITH STEEL PIPE—THE MACHINERY AND TOOLS EMPLOYED.

IT IS a well-known fact that Nature does not furnish us with pure water. The pure article can be obtained only by distillation. But distilled water is absolutely unknown to most people, and would not be relished even if generally supplied, for the reason that the constant use of water containing iron, lime, and other minerals, as well as vegetable and animal matter, in suspension and solution, has so accustomed our palates to the taste of ordinary impure drinking water that, in comparison, the pure water would seem flat and insipid.

It is perhaps hardly necessary to state that no water can be purer than the source from which it flows, and that there is a vast difference between the clear cold spring or Artesian-well water and the discolored liquid, *called* water, that is either pumped, or falls by gravity, from some lake or stream —itself in many cases the trunk line for the sewage of cities and villages thereon, and

heavily charged with animal and vegetable matter and germs of all kinds; or, what is little better, and often worse, water from dug or shallow wells or water holes—worse, because such water is stagnant and therefore not as well aerated as that which flows from lake or stream. Either kind, however, is apt to be warm in summer—unless ice, which is generally impure, is used to cool it—and discolored at all times—unless filtered, which seldom removes the harmful impurities.

The subject of water supply is so broad and far reaching, and so vitally affects everything and every condition on this planet, that it can be classed with, or at any rate ranked as next in importance to, the sun and the atmosphere; and it would be possible to write volumes upon it. But our friend the editor draws the line at a few thousand words and also asks that this article be confined to one branch of the subject—namely, the Artesian well. Even this branch, however, if treated in detail, would fill THE MECHANIC ARTS MAGAZINE several times over, so we will endeavor to be as concise as possible.

The Artesian well, which derives its name from the province of Artois, in France, was used in both Mexico and China, centuries ago; indeed, it is known that the Aztecs of Mexico devised systems of water supply that in some respects rival any now in existence.

Some Artesian wells *flow*, that is, deliver the water to and above the surface, while others deliver to within a few feet of the surface; but all, when properly made, furnish a good supply of far better water than the majority of mankind is familiar with, and effectually shut off all surface water. A study of the death rate statistics of the large cities of this or any other land discovers a large proportion of deaths directly traceable to the drinking of water that is unfit for either man or live stock, even though it *is* drawn from a nickelplated faucet, and even though it is filtered and iced before being drunk.

The appearance and taste of water tell us very little about it; so we have to trust to the good faith of the great water companies. There will, we hope, come a time when the golden rule will prevail, when we shall cease to "do" others because we fear they are endeavoring to "do" us, when every man will understand the laws of health, and when every American citizen will think for himself, vote for himself, be intelligent, healthy, and free, and cease to be in any way a slave. Then, and not until then, will we get cheap and good water, and every other good thing we need.

The drilled hole which constitutes the Artesian well is the same, and is made with practically the same machinery and tools, whether it is drilled for water, oil, or mineral, or merely as a test hole for the foundation of a building. The only real difference is in the size and strength of the outfit, or "rig," as the well-contractor's plant is called. At the present time a test hole is being drilled in Pittsburg, Pa., which is to be 10,000 feet deep. Do you realize what that means? For a distance of nearly two miles a hole is to be driven through earth and rock! Think of the temperature that workmen would have to endure, and the cost and trouble of making such a hole by ordinary digging and blasting!

There are many first-class Artesian wells that are only from 25 to 75 feet deep; for many parts of this country 50 to 60 feet would be a very fair average. Such wells are completed in from 1 to 10 days, and cost from $25 to $200, according to the formation to be drilled through. A fair average cost for wells to supply from 100 to 500 people would be from $100 to $150. Think of going on from year to year paying the water rent you do, when your whole neighborhood, farm, or factory could be supplied free—once the small first cost of the well itself is paid for—with nature's best and purest brew. Or, if you are a farmer or live in an out-of-the-way village, think of the unnecessary suffering and loss the lack of a plentiful water supply costs you yearly.

This good water—not surface water—is to be found at a depth of probably less than 100 feet below the surface of your land. "Yes," I hear some of you say, "but we will have to pump it!" Did you ever get something for nothing? You want water on the upper floors of your buildings. Right you are. An up-to-date man should have modern conveniences; we improve by adopting improvements. The water company you now patronize has either to pump the water for you, or to locate its reservoirs at such an elevation—often several miles from the center of distribution—that the "head," or pressure, obtained is sufficient to raise the water the desired height. But the men who constitute the water company are not in business for their health alone, nor from any personal interest in *your* health, and, considering the quality of the water they supply, they make you pay more than your share of the cost of constructing and

maintaining the pumping plant or reservoirs and pipe lines. Why not get back to first principles and do for yourself—by means of the Artesian well—what you have hitherto been hiring some one else to do for you? You can do it both better and more cheaply. And if, after you personally, or together with your neighbors, have had an Artesian well drilled, it does not deliver the water high enough for you, put up a windmill to do the pumping; or, if you prefer it, use a gasoline engine or any one of the several pumping engines that are to be found on the market.

Some one asks, "Will the water always be cold and soft?" For average depths, the temperature the year round will be about 45° Fahrenheit, and you will save the ice bill, and be saved from the ice impurities. If you are a farmer, packer, brewer, hotel owner, shipper of milk, or a member of any one of the many trades where good cool water is an essential, this point alone will pay you hundreds of dollars yearly. As to softness, if it does not come from lime or similar rock, it will be as soft as you could wish. Comparatively few Artesian wells are hard; but, if you live in a limestone country, most of the water you get will be hard, no matter what source of supply you may use.

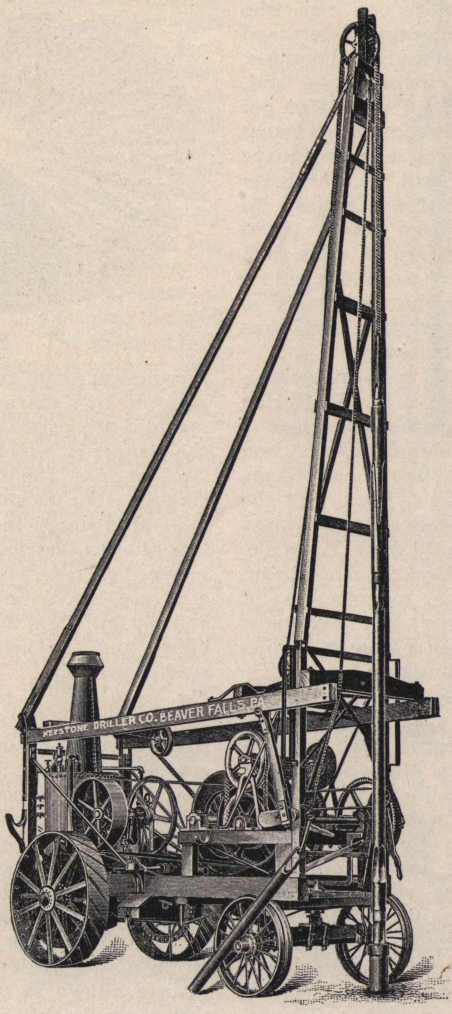


FIG. 1.

In many parts of the world, flowing wells are sure at depths of from 50 to 500 feet. In other sections, Artesian wells that flow over the top with any great pressure are rare, though nearly all sections have some examples. But a good supply that will rise to within a reasonable distance of the top is now an assured fact the world over.

If you have an old dug well that goes dry at times or furnishes a poor supply of poor water, have a 6-inch iron pipe put in the bottom, and drill down until you shut off the surface water and get a supply that is fit to drink. Most dry wells are simply catch-basins for surface water and other impurities, including rats, cats, and so forth. A few dollars paid to the chemist for an analysis of your water supply will be well invested and may save the time and expense of a funeral.

Many Artesian wells are in use today on the Sahara desert.

Oil and gas wells are from 500 to 4,000 feet deep, and cost from $3 to $10 per foot. There is an Artesian well in Seneca County, N. Y., that flows 1,000,000 gallons of water a day. Several in Dakota and other sections flow 4-inch to 8-inch streams with a surface pressure of 150 pounds per square inch, and furnish power to electric-light and power stations, etc., and the water is used for culinary purposes and also for irrigation.

In one town in Idaho, hot Artesian water is piped through the streets and used for warming the buildings. There is a well in California so capped that the water flows from it in the form of an umbrella 40 feet in diameter. The writer was present at the drilling of a well in Fifth Avenue, New York City, that cuts through 2,400 feet of solid rock, and supplies 700 people with water for all purposes. In our new territory, the Hawaiian Islands, irrigation by Artesian wells is now quite common, and in the

borough of Brooklyn, N. Y., more than 1,000,000 people are supplied with a total of 50,000,000 gallons a day from Artesian wells. Many small cities and villages have water works that are supplied exclusively by Artesian wells. California has over 2,500 flowing wells, each of which irrigates on an average 1 square mile of land, or 640 acres. In the same state there is one man who owns 42 such wells. He bought desert land for $1 an acre, drilled wells, planted oranges, raisins, and other fruit, irrigated the land, and now sells it at from $200 to $500 per acre. Did it ever before occur to you what a blessing the Artesian well is to humanity?

The Mormon Church, in Utah, have over 2,000 of these wells, 700 of which flow. In Nevada, at altitudes of from 6,000 to 10,000 feet above the sea, there are 67 wells, each of which flows from 60,000 to 100,000 gallons daily. New York City has hundreds of them, and it is estimated that they save $1,000,000 in water rents yearly.

While the Artesian well, in its crude form, was made centuries ago, it is only during the past twenty-five years that, by reason of improvements in the manufacture of iron and steel pipes and machinery, it has become a prominent factor in the civilization of the world. The first oil well in the United States was drilled in 1859 near Titusville, Pa., by Colonel E. S. Drake. Since then, well drilling and the manufacture of machinery and pipe for it has been a large and growing industry.

FIG. 2.

Those who have never made a study of geology can learn much from a practical study of Artesian well-drilling, and not only about water supply, but about other riches that Nature has in store under our feet—riches that man by his skill and intelligence is so rapidly developing.

Regarding the manner of drilling, and the machinery and tools used in the production of the Artesian well, something will now be said. In most parts of the world there are from a few feet to several thousand feet of earth on top of the various strata of rock. This earth also lies in layers, or strata, of varying thicknesses. Many of the best wells find their supply in water gravel; others find theirs in rock. The drilling machine, as shown in Fig. 1, is placed over the spot where the well will be most convenient. It will be readily understood that drilling a hole through, it may be, several thousand feet of earth and rock is a very different thing from drilling through a piece of wood or iron. In the latter case the drill

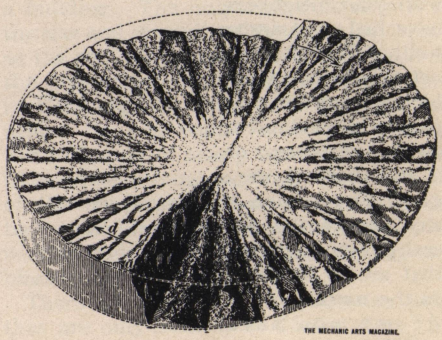


FIG. 3.

is caused to rotate and the wood or metal is removed by a sharp cutting edge. In drilling into the earth the form of the tool and the manner in which it is operated depend largely upon the formation to be drilled through; but for artesian wells the *percussive* method is almost invariably employed. In this, the drilling tool, or bit, hangs from a hawser-laid rope 1 inch to 2 inches in diameter (see Fig. 2) and is alternately raised and let fall, so as to strike a series of sharp blows, and the hole drilled is lined with steel or iron pipe. To cause the flat bit (see Fig. 5) to drill a round hole, the rope is twisted from right to left and from left to right, a dozen or more turns each way; as it gradually untwists, it rotates the bit step by step, so that the bottom of the hole, while drilling is in progress, is somewhat as shown in Fig. 3, in which the direction of rotation is indicated by the arrows *d* and *e*. To hold the bit, to help guide it, to add to the force of its blows, and to release it when from any cause it gets stuck in the hole, there are strung above it certain tools which, with the bit, are known as the "string"; this consists of rope socket, jars, sinker bar, and bit, put together in the order named. In Fig. 4 is shown a good form of *rope socket*, by which the rope is very securely gripped; in another kind the rope is held by rivets passing through it. The *jars* are shown in Fig. 6; they are not usually put on until rock is reached; their duty is to prevent loss of the tools when from any cause they become wedged in the hole; the two parts, *a* and *b* in the figure,

are linked together like the links of a chain; if the bit becomes jammed, a few inches of rope are let off the reel, causing the jars to hang loose; when the engine is started, the two parts come together with a "jar," hence the name of the tool, and quickly free the bit. Sometimes a loose piece of rock will fall in from the side of the hole, and thus wedge the tools; or, a newly-dressed bit—slightly larger than the worn one it replaced—gets jammed; the jars will then free the tools where a steady pull would often completely fail. This points to the advisability of not using a bit too long. The sinker bar (see Fig. 7) is added for holes that are more than a few hundred feet deep, the additional weight being then necessary because the very long column of water through which the tools have to drop retards their speed and reduces the force of the blows. Every so often, as drilling progresses, it is necessary to clean out the hole; for this purpose the sand pump (see Fig. 8) is used. The string of tools being hauled out, the pump is lowered until it strikes the bottom of the hole; in the act of striking, the pipe falls around the projecting end and raises the valve, and some drillings enter the pipe; this operation is repeated by simply lifting and dropping the pump until full, when it is taken out and emptied; on its way out of the well, the weight of the contents keeps the valve closed; when it reaches the top, a man detaches it and carries it to a convenient place for emptying, where he sets it on end—valve down—and allows the weight of the pipe to open the valve and the contents to discharge themselves.

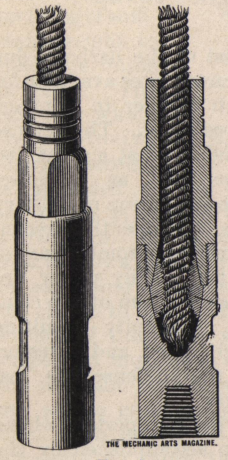


FIG. 4.

By means of alternate drilling, driving, and sand pumping, length after length of pipe is forced into the earth, until the required amount and quality of water is found, or until bed rock is reached. The pipe used is from 4 inches to 24 inches in diameter—6-inch being the best size for ordinary water wells. This pipe, either of iron or steel, is made in 18- to 20-foot lengths. The several lengths are screwed together as they are driven into the earth. It is made in various weights, the manufacturers furnishing whatever weight is ordered; 6-inch pipe weighs from 10 to 30 pounds a foot, according to its thickness.

Water is poured into the pipe as drilling and

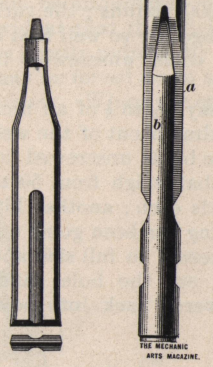


FIG. 5.

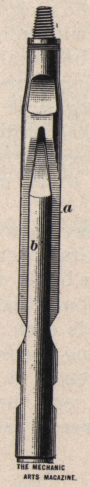


FIG. 6.

FIG. 7.

FIG. 8.

driving progress, and the drill, which weighs from 300 to 4,000 pounds, is raised by the engine, and allowed to drop, 30 to 80 times a minute. The drill crushes and grinds earth and rock into powder, of which the water makes mud and slush, which is periodically pumped out by the sand pump, as already fully described. As the hole is deepened, more pipe is screwed on and driven, either by a driving maul weighing several hundred pounds or by the string of tools. If the latter method is adopted, the tools are let down into the pipe for a few feet, and a clamp screwed to them so as to strike on a drive cap on top of the pipe; as the tools are very heavy, and are raised and dropped many times a minute, they drive the pipe very rapidly, sometimes at the rate of from 25 to 100 feet a day, depending on the formation driven through.

There is a heavy steel shoe on the bottom length of pipe to prevent stones and boulders from crushing it in. Sometimes the drill works ahead of the pipe and makes a hole for it to follow in—that is, if the formation will stand up; at other times the pipe is driven first and afterwards drilled out; the driller must use his judgment about this and many other matters.

If satisfactory water is not found before

rock is reached, the pipe is driven hard to make a tight joint with the rock and thus shut off surface water, and the drilling is continued in the rock, and no more pipe used, the rock forming the wall of the well, if the latter is not more than a few hundred feet deep. The water thus obtained is from the veins or seams in the rock.

Each driller carries with him a complete blacksmith outfit, and he usually has plenty of use for it. The string of tools is from 15 to 50 feet long, and weighs, as already mentioned, from 300 to 4,000 pounds; the various tools are screwed together so well that it is very seldom they come unscrewed in the hole.

When a bit wears, say, $\frac{1}{16}$ to $\frac{1}{8}$ of an inch smaller, the tools are drawn out of the well by the engine, and the bit is unscrewed by heavy tool wrenches that weigh from 50 to several hundred pounds each; another bit, which, while the drilling has been going on, the blacksmith has dressed to full size and proper shape, is put on, the hole sand-pumped, the tools lowered back into position, and the drilling continued. The hole should be kept as nearly as possible the same diameter from top to bottom, and perfectly straight and plumb.

When the proper quality and quantity of water is found, the well is tested by means of the sand pump or by a power or steam pump or ejector; then, if all is satisfactory, it only remains to place the necessary pumping apparatus, that is, in case the well does not flow.

The speed of drilling varies from a few inches to sometimes 50 or more feet a day, according to the nature and hardness of the formation.

In conclusion, it is only just to say that for the illustrations accompanying this article the writer is indebted to the Keystone Driller Co., Beaver Falls, Pa., who are probably the best known manufacturers of well machinery. To any one who wishes to more fully investigate this subject, the company would no doubt send their catalogue, which contains some important as well as interesting details.

SUBMARINE MINES.

Ernest K. Roden.

WHY THE SUBMARINE MINE IS A NECESSITY IN MODERN NAVAL WARFARE—CONSTRUCTION AND OPERATION OF MINES—THE CAMERA OBSCURA AS AN OBSERVATION TOWER.

BEFORE the days of steam power, when a warship attacking a fort was more or less at the mercy of winds and currents, experience proved that one gun ashore was more effective than many afloat. But the introduction of the screw propeller, followed later by that of armor-plating and big guns mounted on speedy vessels, wrought great and radical changes in this direction, for it left a hostile fleet free, under cover of darkness or fog, to move swiftly past shore batteries, and anchor securely in positions from where their fire could destroy the adjacent city or compel the payment of an enormous ransom. Furthermore, the enemy's ships—under better control, less vulnerable, and possessed of much higher speed than formerly—were to be encountered by guns more unwieldy and, in most of the harbors, due to the naturally contracted sites available for shore batteries, much smaller in numbers than those afloat. The defense thus found itself at a great disadvantage, and as a consequence the attention of military engineers was urgently directed to the devising of some means of holding the enemy under fire and depriving him of the comparative immunity resulting from high speed, and so restoring to the defense its lost superiority.

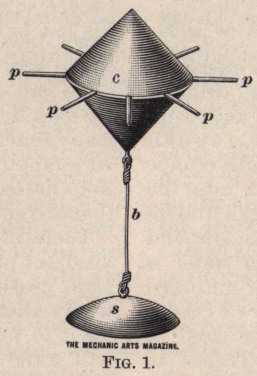


FIG. 1.

This vitally important object has been accomplished by the modern submarine mine, the destructive power of which has made it an essential auxiliary of the land gun. In a judicious system of harbor defense these mines are indeed indispensable, for, while the guns are necessary to develop

the full power of the mines, the latter are no less essential as a protection for the guns. Thus, submarine mines are invariably defended by heavy guns placed in batteries secure against landing parties; otherwise, the enemy's small boats could creep for them or else clear a passage through them by exploding so-called countermines.

Submarine mines were extensively used by the Confederates during the Civil War, and Germany made good use of them during the Franco-Prussian war in keeping the French fleet from bombarding her ports. Since those times, however, and especially recently, great improvements have been made in the mechanisms employed, and the introduction of high explosives, such as dynamite and guncotton, instead of gunpowder, has immensely increased their power and destructive range.

The simplest form of mine is represented in Fig. 1; this is the *contact mine*. It consists mainly of an iron case *c* which is connected by a cable *b* to the sinker *s*, the latter being of sufficient weight to hold the mine in place. The case *c*, in which the explosive charge is stored, is provided with a number of projecting points *p*, each of which is armed with a firing pin. If any one of these firing pins is struck by a passing vessel, it will be driven in, exploding a percussion cap and causing the charge to burst. The distance below the surface of the water at which the mine is suspended must be so arranged that it is not too near the surface when the tide is low, nor at too great a depth when the tide is high. An immersion of at least 8 feet is necessary to cause the charge to explode with sufficient force to destroy a modern battle-ship; hence this should be the depth of the mine at low water. If the difference between high tide and low tide is very great, it may not be possible to make the contact mine effective for all conditions; this is a defect, to remedy which numerous devices have been suggested, the main idea being to automatically increase or diminish the length of the attached cable as the tide rises and falls, thus keeping the mine at a constant distance below the surface.

In its simple form, the contact mine is dangerous to friend as well as to foe, and, if it gets adrift, it may sink a harmless merchant ship; the only reasons for its use, then, are its simplicity and the fact that it can be improvised at short notice. It is evident that the efficiency of this mine will be greatly reduced by a strong current, for it may be forced down so far as to be rendered useless. Where the currents are rapid, therefore, and in narrow channels, these mines are usually placed on the bottom, and are then called *ground* mines—a class which we will describe later.

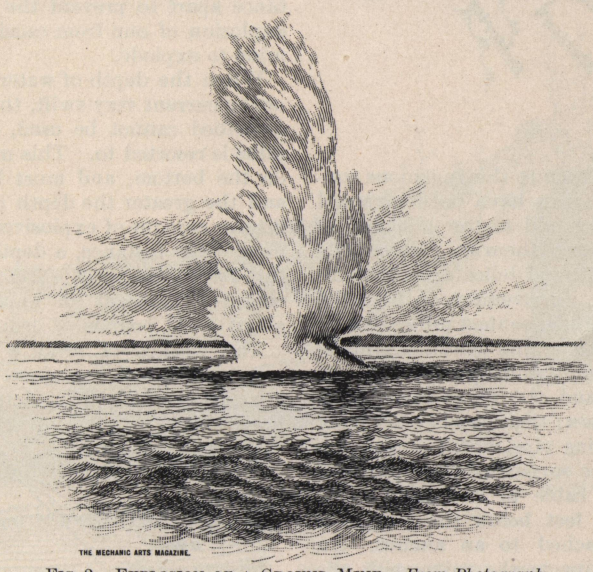


FIG. 2.—EXPLOSION OF A GROUND MINE. *From Photograph.*

Nowadays, electricity is the chief igniting agent used in submarine warfare, because it enables the obstructed channels to be safely traversed by friendly vessels. The electro-contact mine is constructed on the same general principles as the contact mine, but some of the weaknesses of the latter are absent. When one of the firing pins is driven in, instead of exploding a percussion cap, it simply closes a break in an electric circuit that passes through the charge, and this does not necessarily explode the charge, for the following reason: There is an electric cable leading from the charge to the sinker, or anchor, and thence to a station on shore; at this station there is another break in the circuit, and, unless this latter break has previously been closed, the driving in of the firing pin will not explode the mine. Herein is an element of safety to friendly ships. When no enemy is in sight, and friendly ships are passing in and out, the break at

the shore station is left open, so that if a mine is struck it will not explode. Thus, a vessel chased by an enemy's cruiser could pass over the mines with absolute safety, while to the pursuer they would at once become deadly engines of destruction. In these mines the firing pins are fitted with springs, which cause them to return to their proper positions in case they are accidentally

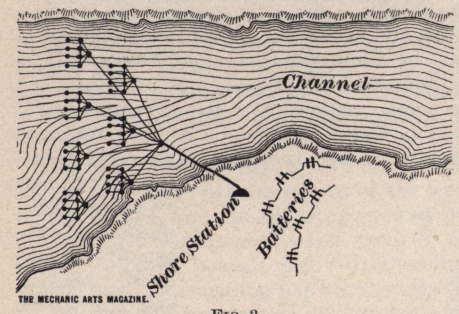


FIG. 3.

driven in. In addition to this ingenious contrivance, many devices have been invented and adopted which add to the efficiency of the mines, and most of them are perfect little marvels of ingenuity and delicate mechanism.

But there is an improvement on both the contact and the electro-contact mines, which is now used whenever the conditions make it possible. This is the *observation* mine. Here, the mine and the firing mechanism are in separate cases; there is a contact buoy containing the firing pins, which is placed a few feet below the surface of the water and connected by a cable to the mine itself, which is several feet below the buoy, the whole being attached to an anchor. An electric cable connects the mine with the shore station and there are, for each mine, two distinct and separate electric circuits, one for signaling and the other for firing. Whenever a firing pin of the contact buoy is touched, the signaling circuit is closed, and this either rings a bell or displays an electric light at the shore station. Under each bell or signal light, whichever it may be, is a key for closing the corresponding firing circuit.

When one of the bells rings, the observer at the keyboard in the shore station knows that the buoy above the corresponding mine has been struck, and he immediately touches the key below that bell and thus closes the firing circuit and causes the mine to explode. The shore station should be underground, and large enough to allow the operator to be comfortably seated within easy reach of the firing battery and key. If possible, the station should be hidden from view with bushes or whatever vegetation may grow around; if in barren ground, the roof should be painted as nearly as possible the same color as the surrounding soil. These precautions are very important, since a single well-aimed shell from an enemy that discovers the station will render a whole mine field useless.

Observation mines are usually placed in groups of from four to seven, as shown in Fig. 3. The groups are placed in two or more lines, so that a ship which happens to pass *between* the groups of one line will surely pass *over* the mines in the next line; and the mines are anchored at a sufficient distance apart to prevent the shock from the explosion of one from causing the adjoining mine to explode.

When the depth of water is considerable, or the current very swift, the mines hitherto described cannot be used, and the ground mine is resorted to. This mine simply rests on the bottom, and must be quite heavy; and the greater the depth of the water, the greater amount of explosives will have to be used. For instance, a depth of 65 feet will call for a charge of 1,200 pounds of gun-cotton—equivalent in explosive power to about 4,800 pounds of ordinary powder.

The method of firing a ground mine is very simple and ingenious. Two observers are usually employed to determine when the hostile ship is directly over the mine. The

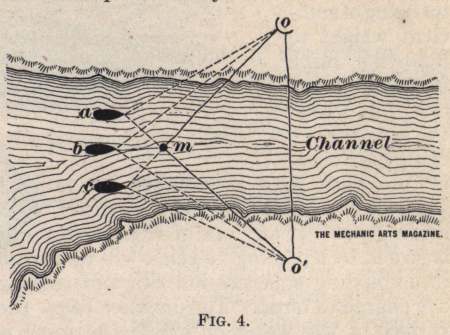


FIG. 4.

two shore stations, o and o' in Fig. 4, and the mine m are all in the same electrical circuit, being connected by a cable in which are two circuit breaks, one at each station. These two breaks must be closed simultaneously, or the mine will not explode. Each observer has a telescope fixed on a vertical pivot which permits it to swing toward any point on the horizon, and each telescope is so arranged that when

pointing directly towards the mine the break at the electrical circuit at that station will be closed. The observers, therefore, simply keep their telescopes pointing toward the advancing ship; then, if the enemy passes over the mine, both telescopes will at the same instant be pointing toward him and also toward the mine; this will cause both breaks in the firing circuits to be simultaneously closed, and the mine will explode under the ship. This would be the case with the ship at *b* in Fig. 4, provided she keeps her course, while the ships at *a* and *c* will not pass over the mine. With ships *a* and *c*, then, the two circuit breaks will never be closed at the same time, and the mine will not be exploded. This very simple but ingenious system prevents a valuable ground mine from being needlessly exploded.

During the defense of Venice in 1859, ground mines exclusively were used. The Austrians, who at the time had possession of the city, decided to plant mines in the harbor and in the channel leading to it, to prevent the Italian fleet from entering; their method of exploding the mines is illustrated in Fig. 5. A camera obscura was placed at a convenient spot overlooking the harbor, in such a position that the mirror *m* reflected the view through the lens *e e'* upon a large white table *T*; in this manner every movement of any vessel in the harbor was rendered plainly visible to the officer within.

The mines were now sunk, while an observer in the camera tower made a pencil mark, indicating upon the table the exact location of each mine, and in addition put down the number corresponding to it. This complied with, a boat was rowed in a circle around the spot where each mine had disappeared, to indicate its zone of destructiveness, and the man in the tower, watching the moving image of the boat, traced a corresponding little circle upon the table. In this manner a picture, or map, of the harbor was obtained, upon which were small numbered circles indicating the location and number of each mine. Inside the tower and within easy reach of the observer were electrical wires leading to the several mines. During an attack, the duty of the observer was to watch the approaching fleet as reflected on the camera table, and, as soon as he saw a vessel come within one of the little circles, to at once explode the corresponding mine by closing the circuit in the wire leading to it. Of course, this optical system could be used in the daytime only, unless at night the harbor was well illuminated with electric light.

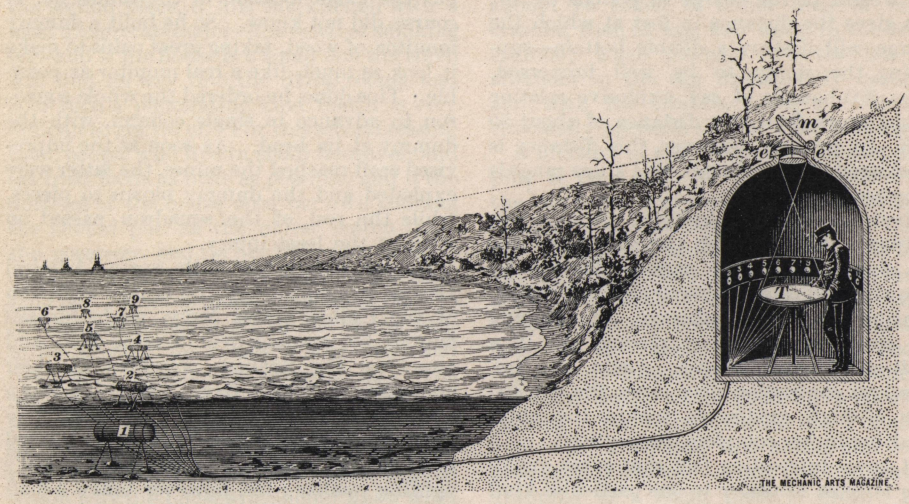


FIG. 5.

In many forts that guard the entrance to a harbor, the guns are mounted in such a manner that they cannot be trained upon the inner harbor, so that a ship that has succeeded in penetrating to this inner harbor would be practically free to use her guns, and cause what damage she wished upon the rear and flanks of the forts. Such harbors are generally supplied with ground mines containing enormous charges of explosives, for the purpose of reducing the intruder to fragments.

The explosives now most commonly used in submarine mines are guncotton, dynamite, and explosive gelatine. These are superior to gunpowder, not only because their destructive power is, weight for weight, from four to six times as great, but because they are not seriously affected by moisture; in other words, a leak in the case containing the charge will not render it useless, as it would if gunpowder were used. The pressure necessary to blow a hole through the bottom of a modern battle-ship has been estimated to be from 6,000 to 10,000 pounds per square inch.

To find the approximate distance at which a given charge of high explosive will be fatal to a ship's bottom, the rough rule is to divide the weight of the charge in pounds by 10; this gives the distance in feet at which the charge will destroy a double bottom—supposing the charge to be well immersed. Thus, 500 pounds of, say, explosive gelatine would prove fatal at a distance of about 50 feet. In practice, however, this distance is considered the maximum, and a less range is expected.

Even where the explosion of the mine fails to blow a hole through the ship's bottom, the shock may cause serious damage by throwing delicate machinery out of action, injuring electrical appliances, or stopping the ship's engines, thus placing her in a position of much danger. Again, the tremendous concussion may cause the detonation of high explosives within the ship, resulting in her complete destruction.

It is an interesting fact that every explosive is most sensitive to one particular kind of shock or vibration; that is to say, a shock or vibration that will cause the explosion of one charge will not necessarily cause the explosion of any other; but if that explosive is subjected to that shock—even though comparatively light—it will be very liable to explode. It is therefore of paramount importance, on board a man-o'-war, to store the high explosives where they will be free from shocks or violent vibrations; and it is equally important that the defenders cause such violent vibrations as to render the invader harmless.

In connection with the history of submarine mines, there are many records of bravery and heroism. During the Civil War, the Confederates were particularly clever in the use of mines for obstructing channels and rivers; and during the struggle no less than twenty-five ships of war fell prey to them, in addition to the many that were more or less injured by them. How Admiral Porter took his squadron safely through a field of mines by the adoption of a clever ruse is a matter of history so well known as to need but passing mention. The admiral well knew that the river was "planted," but the exact location of the mines he, of course, did not know. So he built a dummy monitor, of wood, taking great pains to make it look as much like a real monitor as possible. This done, he ordered the whole squadron to advance in single column, with the dummy at its head. As soon as the improvised craft reached the mines, the latter were exploded and the dummy blown to pieces, while the rest of the squadron passed on without the least injury.

In our recent war with Spain, Admiral Dewey, in command of the Asiatic squadron of the United States Navy, made himself famous by running over a mine field and attacking the Spanish warships at their anchorage in Manila Bay. Truly this was a risky undertaking, to enter a comparatively unknown harbor that he knew to be planted with mines, and it proved the admiral's fighting quality; for, however brave a man may be, he may be excused for thinking twice before engaging with an enemy that he cannot see. Sailors have a great and natural respect for submarine mines, and usually give them as wide a berth as possible. At Manila, judging by the mines that were exploded in the wake of the squadron, Dewey evidently caught the Spanish operators "napping" at their shore stations, and in this no one will deny that he was fortunate.

STEPPING STONES IN THE ART OF COOKING.

Mrs. Henry Esmond.

STEP III : FRYING ; CHOICE OF FAT ; PREPARATION OF THE FOOD MATERIALS.

FRYING, of which there are two distinct kinds, is cooking in hot fat. There is *deep-fat* frying, the name of which explains itself, and *sautéing*, or frying in a small quantity of fat in a shallow pan. For more than one good reason, people would be wiser if they did not eat fried food at all. In the first place, it is very indigestible ; in the second place, it fills the kitchen with a most disagreeable odor—the smell of smoking fat—and if the house is a small one the smell will find its way into the living rooms, and is of such a penetrating kind that it is very difficult to get rid of. For this second reason, then, people who live in small houses should eat fried foods as little as possible, and if the mistress of the house does her own cooking she should put on the oldest cotton dress she possesses, and tie her hair up in a thick cloth, so as to exclude the fumes of the smoking fat. What is more unpleasant than to enter a house that smells of the frying pan, to be greeted by a lady whose hair and clothing is redolent of smoking fat! The fact that fried food is indigestible will, we fear, never stop an American from eating it, and, as food properly fried is much less indigestible than food badly fried, there is good reason why the housewife should know what there is to know about the art of doing it well.

We will begin with deep-fat frying. Many people imagine that the fat in the frying pan boils, because, when hot enough to cook in, it bubbles. This is a mistake ; fat does not boil until it reaches a temperature of between 550° and 600° Fahrenheit ; whereas the proper temperature to do frying in is about 385°. It is true that at the latter temperature the fat bubbles, but this is caused by the water in it evaporating.

When a food material is immersed in hot fat, the result is similar to that explained in previous articles in connection with boiling and roasting—the albumen on the outside is hardened, and thus the juices in the food are retained. The secret of successful deep-fat frying is to have the fat hot, and to have plenty of it.

Articles to be fried should first be dried, then dusted over with flour. This prevents any water that the food contains from escaping into and lowering the temperature of the fat, in which event the food will soak up the fat and become not only very greasy and unpalatable but also exceedingly unwholesome.

Fish, meat, croquettes, and fish balls should be rolled in either flour or bread crumbs, then in egg, and again in the bread crumbs ; when plunged into the fat, the albumen in the egg immediately hardens, and, with the crumbs, forms a crust that effectually prevents the fat from soaking in.

A mixture of pure lard and beef-suet dripping is very good for frying purposes, but the lard alone is preferable. Suet from lamb or mutton should not be used, as it has a very strong taste and odor. Olive oil is best, but as this is very expensive it is rarely used. A product of the cotton seed, called *cottolene*, is much used down South, and, if fresh, is very good, though many people object to it because of its peculiar odor.

An iron kettle with a good lip or spout for pouring is best to heat the fat in. Put about 2 pounds of fat into this kettle, and let it heat until it smokes. Then test the heat by dropping in a small piece of bread ; if it browns while you count 30 seconds, the fat is hot enough to cook raw potatoes, doughnuts, fritters, etc. For cooking croquettes, fish balls, or anything made of food that has been cooked before, the fat must be hotter ; for these the bread must brown in 20 seconds.

The articles to be fried should be placed in a frying basket—a wire basket made specially for the purpose. Never drop the articles into the fat singly, as it is then impossible to get them all out at the right time ; and do not put too many in the basket at one time, or the fat will be cooled so much that instead of being cooked the food will soak up the fat and be spoiled. Have upon the stove, at your side, a large dripping pan with several sheets of unglazed paper in it, upon which to drain the food after cooking. Taking hold of the handle, plunge the basket into the hot fat—letting it become entirely immersed—and keep it there until the

articles are done; then, raising the basket, hold it over the kettle until the adhering fat has dripped off; then empty into the dripping pan. Do not allow the separate articles to touch one another while on the paper, and you will find that much of the fat remaining on them is absorbed.

Before the fat is put away, after use, it should be clarified. Take a large potato and cut it into slices about half an inch thick, and, after the fat has cooled a very little, drop them into it and set aside where it will not be disturbed until quite cool; then, before it has begun to solidify, pour off into a crock or pail kept for the purpose, and it will be found that all the particles of food, flour, crumbs, etc. that had escaped into the fat have settled to the bottom with the potato chips. This fat can be used many times if care is taken in the clarifying of it.

In sautéing, a very small quantity of fat is used—enough merely to well cover the bottom of the pan. Hash, fish steaks, potatoes, small steaks of veal or pork, omelets, eggs, etc. should be sautéed. The pan should be heated, and a heaping tablespoonful of fat melted in it; then the food material, after being prepared as already described in connection with deep-fat frying, put in and quickly browned, first on one side, then on the other. Cakes of all kinds that are cooked on the griddle are, in reality, fried, though no more fat is used than is needed to prevent them from sticking to the griddle.

CURRENT TOPICS.

Mrs. Frederic R. Honey.

Transformed Africa.—part ii.

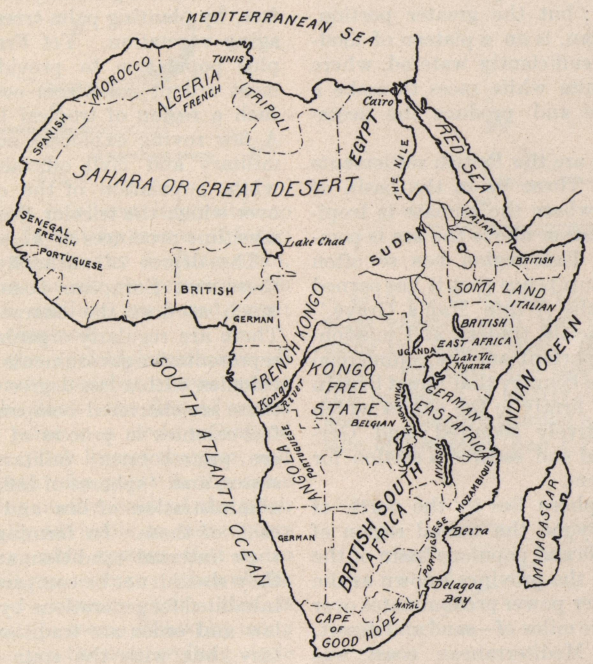
THE study of the history of any country will show that its development is closely connected with its natural physical conditions, its position, and its configuration—in short, with its geography. And a glance at the geography of Africa, as revealed by modern explorers, explains the surprising fact that the interior of this great continent, lying in the pathway of ocean travel and within sight of Europe, should have remained a sealed book until the nineteenth century had left youth behind. Egypt, it is true, was in the forefront of ancient civilization, and northern Africa shared in the vicissitudes of early European history as a part of the European system, washed as it is by the waters of the Mediterranean, the "Great Sea," once the highway of commerce for the civilized world. But Egypt is only a narrow belt, intersected by the Nile; and northern Africa was cut off, as it is today, for all practical purposes, from the rest of the continent by the impassable barrier of the Sahara.

Elsewhere than in the north, African geography is peculiar, and of a character calculated to discourage the explorer who seeks new lands for settlement by civilized men. It is estimated that a full half of the continent is occupied by deserts, and by infertile lands approximating to the desert character. Around the coasts, where good harbors are few and far between, lies a belt of lowland from 100 to 300 miles in width, where malarial fevers of all kinds prevail; in some parts the white man is a sure prey to tropical disease. From this low belt the land rises steeply in a succession of terraces to the central plateau, which in the south and east attains a great elevation; far less than that of central Asia, but quite high enough to be a hindrance to the migration of newcomers, which naturally follows the lines of least resistance. In most regions of the world the rivers form natural highways by which a country can be entered and explored; but African rivers are rendered impassable by rapids as they descend from the elevated plateau to the lowlands of the coast. What wonder, then, that the traveler who found himself barred from access to the interior, turned his back on Africa and sought more hospitable lands?

The configuration of Africa is thus the key to its history; for the inaccessibility of its highlands and its unhealthy coast, combined with its tropical situation, have contributed to the late settlement of European colonists. But these obstacles are no longer effectual hindrances; and under the impetus of a need for colonial expansion on the one hand, and of political rivalry on the other, European influences have now taken firm root.

Our maps show that seven European powers have claimed a share in Africa; but,

for the present, little interest attaches to five of these. Germany's occupation is very recent, and has been attended by no striking incidents; while Spain and Italy, in their small coastal territories, chiefly lowland, are inert and unprogressive. Portugal has a long coast line, but she has neither the wealth nor (apparently) the energy necessary for the development of the healthier "hinterland" in which colonies might be planted—notwithstanding the hopeful and ambitious utterances of her statesmen respecting the future. Her ports of Beira and Delagoa Bay on the east coast are mainly used by foreign nations for their own commercial purposes. The day may come when these countries will give a better account of their stewardship; if they fail to do this, their inheritance will probably be absorbed by those who prove themselves more capable administrators. The Kongo State, under Belgian control, occupies the fertile basin of the second largest river system in the world, once the bed of an inland sea. It is still in the initial stages of development, but steady progress may be expected, now that a railway has connected the coastal lowlands with the Kongo River above the rapids which render it unnavigable as it descends from the interior plateau to the Atlantic through a channel from four to eight miles in width. The future of the Kongo State may be great; but for the present the British and French possessions are of more general interest.



The sphere of Great Britain lies mainly in South and East Africa, and includes the greater portion of the subtropical lands which are favorably situated for European settlement. It is fortunate for Great Britain that her occupation began thus at the south, whence the natural line of expansion was along the elevated axis of the continent, whose general direction is northeast, towards the shores of the Red Sea. Commencing with a modest colony at the Cape of Good Hope, which was ceded by the Dutch in 1814, her boundaries gradually extended by ordinary processes of growth, including Natal and Zululand on the coast, and Bechuanaland on the north. As was suggested in a previous article, the sudden appearance of Germany on the stage of African affairs in 1884 hastened the apportionment of such parts of the continent as were not already under European influence, and Great Britain's African frontier was pushed rapidly forward. Although the great acquisition, known as Rhodesia or Charterland, has only recently come under her flag, a railway already penetrates many miles into the heart of the country, which five years ago was under the rule of barbarous tribes. Its boundaries skirt the western shores of Nyassa, one of the lakes which form so remarkable a feature of East Africa, and touch the southern point of the long, narrow Lake Tanganyika, on which navigation is free to all nations. Two hundred miles beyond the northern point of this lake, lies Uganda, a district of British East Africa, bordering on the great Victoria Nyanza, the source of the White Nile and second only to Lake Superior among inland fresh-water seas. Thence along the Nile the British power predominates without interruption through the Sudan, the scene of Lord Kitchener's recent overthrow of the Dervish forces, and through Egypt, which is virtually under a British protectorate. (See HOME STUDY MAGAZINE, December, 1898, page 526.)

A British railway "from Cairo to the

Cape" was regarded not long ago by sensible people as an extravagant fancy, conceived in the brain of an enthusiast. Large sections of such a railway, however, already exist in North and South Africa, and a space of only 500 miles in the center of the continent separates the British territories in which it can be constructed, when commercial necessities or the protection of the country demand it. The surface of this wide belt of land varies greatly. There are desert spaces in the south and west; infertile lands where cattle raising is the only profitable agricultural industry; mining districts awaiting development; the famous diamond fields of Kimberley; lowlands in river basins and on the coast, where the prolific soil breeds malarial disease; but the greater portion, south of the Sudan, is on a plateau of moderate elevation, sufficiently watered, where the climate permits white races to make a permanent home and produce the necessaries of life.

Quite different are the British settlements in West Africa. These lie in the basin of the river Niger, where the climate is tropical, and the elevation above the sea is comparatively low. This region has so often proved fatal to Europeans that it has earned the name of "the White Man's Grave." Yet here are officials, traders, and missionaries; and so important are the commercial possibilities of the country that Great Britain and France hold firmly to the shares which each has respectively acquired; and Germany has claimed and secured a section for future development.

The French sphere lies in the north of Africa, where, beyond the coastal region of Senegal, the fertile and populous basin of the upper Niger, and the province known as the French Kongo, her power predominates over two million square miles of—sand and desert. Algeria, on the Mediterranean coast, was won by forty years of fighting with Arab tribes, and has now an orderly government; but, notwithstanding the beauty and charm of the maritime portion, the desert character of the "hinterland" forbids profitable expansion. Nor, even were the country fitter for settlement by Europeans, are the French successful colonizers. Their brilliant imagination, enterprise, and courage fit them better for conquest than for commerce or colonization, as is demonstrated by the history of the past. They are enthusiastic explorers, and dream of future control of the northern half of the continent, from Senegal to the Red Sea, including the basin of Lake Chad at the south of the desert, and the upper part of the Nile valley. Suggestions have been made for moderating the climate of the waste region, and for promoting commerce by providing it with water communications. The Sahara was once the bed of a salt lake; and it is proposed to reopen the connections with the Mediterranean which Nature has gradually closed, and thus transform a part of the desert into an arm or inlet of the sea. This sounds chimerical; but what may not the twentieth century see? Meanwhile, with praiseworthy skill and industry, efforts are being made to redeem in part the desert barrenness; oases are cultivated, and are even created by boring for water which is generally found near the surface, by planting palm trees, and by encouraging vegetation. Yet France has no surplus population to provide for; and the most ardent colonizers could not settle in such a region of tropical heat and aridity. A few roving explorers, and the necessary military and civil officials, constitute the white population of the quarter of Africa over which the tricolor floats, except in the maritime provinces of Algeria and Tunis.

The degree of authority exercised over these vast European possessions differs as much as does the character of the soil. There are regularly organized colonies with representative governments; there are crown colonies, with a less degree of independence; there are chartered companies, which are in fact colonies in process of formation; there are protectorates; military posts; native states, and "spheres of influence"; and the administration of law and justice varies in each of these. In forming a judgment of their internal condition and management, they should not be compared with countries inhabited for generations by races with whom law and order are traditionary and hereditary, but with the state of things which existed in Africa fifty years ago. And it should be remembered that the whites are as yet but a small minority of the population, even in the older settlements. Rough and ready as the methods of administration may be in districts where white men are still pioneers, the standard of justice—as Christianity and civilization demand that it should be—is incomparably higher than the tyranny of force exercised by the native tribes when their power was unbroken. No less a result could justify the experiments which are now being tried on so large a scale and with such keen competition by European nations in Africa.

GOOD SCHEMES

GEAR-TOOTH LAYING OUT SCHEME.

Harland Tuttle, Battle Creek, Mich.

THE FOLLOWING method of laying out tooth profiles, without employing the odontograph, is useful to draftsmen, but is intended especially for patternmakers, because they require—what they are generally without—the means of obtaining the theoretical profile

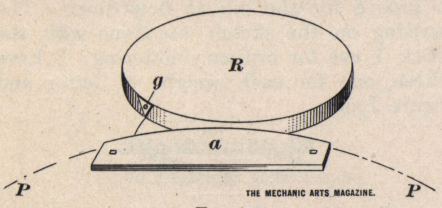


FIG. 1.

with accuracy. It is almost impossible to make an accurate layout by means of intersecting lines as used in the drafting room, but, by applying the simple principles on which the tooth outlines are based, great accuracy can be obtained.

Taking, first, the cycloidal teeth, we all know that the profile consists of two curves —the face and the flank—the first of which is the path of a point in a circle rolling on the *outside* of the pitch line of the gear, and the second the path of a point in the same circle while rolling on the *inside* of the pitch line. It is usually advisable to make gears on the interchangeable system, that is, so that any gear will run with any other of the same pitch; this is accomplished by using the same rolling circle for all gears of the same pitch, and it is customary to make the diameter of this circle equal to the radius of the smallest pinion in the set, the result being radial flanks for this pinion, which custom has decided shall have twelve teeth.

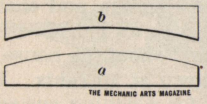


FIG. 2.

Now, suppose we wish to make a pattern of a gear of certain circular pitch: First find the diameter of the rolling circle, then turn up a wooden disk as at R, Fig. 1, of exactly this diameter; let into the edge of it, as at g, a triangular piece of sheet steel, one point of which has been carefully sharpened so as to extend about $\frac{1}{100}$ of an inch below the under surface of the disk. Then make two sheet-zinc templets a and b, Fig. 2, one (a) to fit the inside of the pitch line, and the other (b) to fit the outside. Now fasten to the drawing board a square piece of sheet zinc, and scribe upon it a portion PP, Fig. 3, of the pitch circle of the gear. Brad down templet

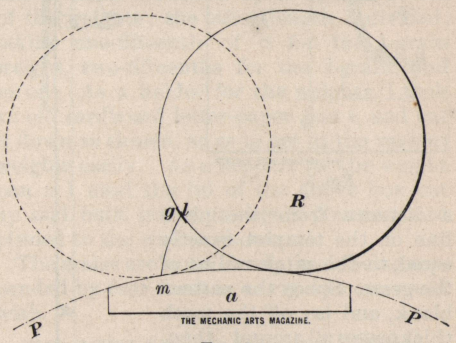


FIG. 3.

a, as in Fig. 3, so that the curved edge coincides exactly with the pitch line; then, using the rolling circle, that is the wooden disk, "roll out" the face ml of the tooth; this operation is clearly indicated in Figs. 1 and 3. Remove templet a, and on the other side of the pitch line PP, fasten templet b,

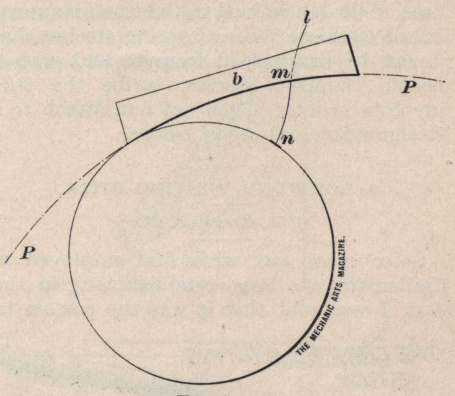


FIG. 4.

as in Fig. 4; then, using disk R, and taking care to start with the scribing point, exactly at m, roll in the opposite direction and thus obtain the flank mn. Now draw the addendum and root arcs lx and ny, Fig. 5, and through the center of the tooth

draw st towards the center of the pitch circle. Remove the square piece of zinc, Fig. 5, file out the profile $ynmlx$, and fasten, as in Fig. 6, to a straightedge that is long enough to reach beyond the gear center; do this in such a manner that one edge coincides exactly with the center line st of the tooth. Stick a needle into the center of the gear; cut a notch n into the straightedge at

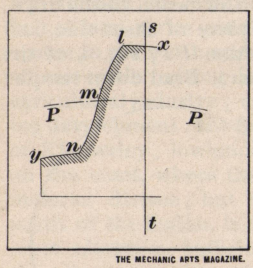


FIG. 5.

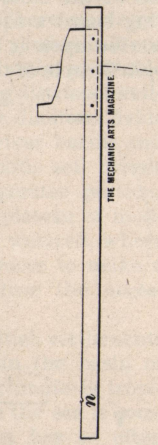


FIG. 6.

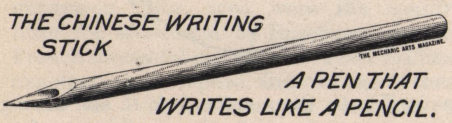
a distance from the pitch line on the templet exactly equal to the pitch radius of the gear. Space the pattern blank, and lay off the tooth thicknesses all around; then, placing the notch n against the needle, scribe the outlines of one side of all the teeth; reverse the templet and scribe the other sides.

For involute teeth the templet is used in a precisely similar manner; but, to obtain its outline, instead of using a rolling circle, use a portion of a disk the same diameter as the base circle determined in the usual manner; attach to this a piece of spring steel so that it can be unwrapped from it, and with a needle clamped thereto, scribe the true involute profile. Then cut out, attach to a straightedge, and use as before.

A BOXWOOD WRITING STICK.

Alpha, Cincinnati, Ohio.

SOME YEARS ago, when first employed as draftsman in a large establishment in the east, I was told that it was the custom in



that office to use the Chinese writing stick, instead of an ordinary pen, for printing all letters and figures on drawings. The idea was new to me, but I soon got accustomed to the stick; in fact, I came to prefer it to any pen I had ever tried. Since then I have wondered why it is not in general use, for it is certainly unequaled for some classes of work, particularly if, as in the office referred to, drawings are made and inked in on bond paper and blueprinted direct instead of from tracings. The illustration clearly shows the form of the stick; it is made of boxwood, a little slimmer than an ordinary pencil. To make, you sharpen the end carefully, flatten off one side, and hollow this out with your pocketknife, letting the hole at the deepest part go just about through. Towards the point, for $\frac{1}{4}$ inch or so, the hollow is simply a groove for the ink to flow down. The writing on the sketch was done with the stick I use for ordinary lettering; I have three, one for each weight of letter and figure I use.

TO DRILL GLASS.

F. W. S., Marilla, N. Y.

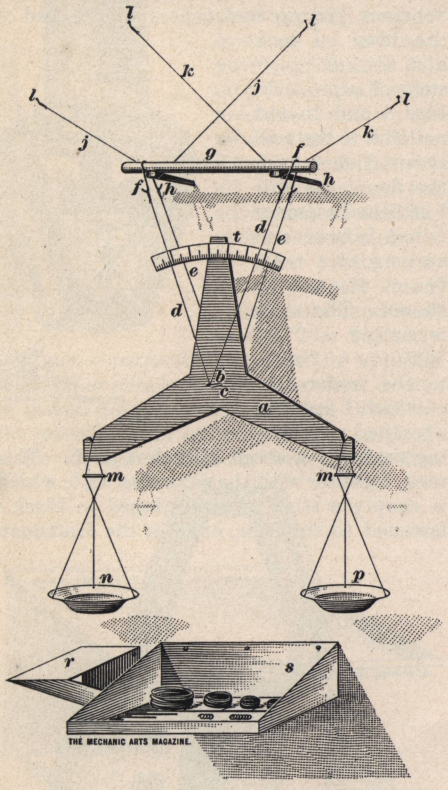
IN THE MECHANIC ARTS MAGAZINE, March 1899, Answers to Inquiries, No. 49, you describe a very excellent way to drill glass. The following is another way which I have used myself and know to be all right: Use a common flat drill, tempered very hard by cooling in salt water; put a block of soft wood under the glass, and drill with fairly light pressure; lubricate freely with turpentine in which camphor gum has been dissolved.

COMPLETE SET OF PHOTOGRAPHIC SCALES AND WEIGHTS FOR TEN CENTS.

Kodaker.

THE ACCOMPANYING figure is an exact representation of a set of scales and weights that I made one morning not long ago, and that cost me in cash just 3 cents; as I made use of some things that I found about the house, I put the actual cost down at 10 cents. I use it in my dark room for weighing out so many grains of this and so many grams of that, when preparing the solutions. The smaller weights are accurate to $\frac{1}{100}$ of a grain, and a weight of $\frac{1}{8}$ of a grain distinctly disturbs the balance of the scales. So much for the accuracy of the rig. I made it in the following manner: I happened to have a piece of $\frac{1}{4}$-inch poplar, about 12 inches square; out of it I sawed the three-legged-piece a. Holding this horizontal, I balanced it on the point of needle b, then pushed the needle through; from the opposite side, and as close as possible to needle b, I pushed through another

needle *c*. I then threaded the needles with silk threads *d* and *e*, and tied the ends to hairpins *f*, bent as shown; hanging these over a wooden rod *g* (whittled out of a piece of wood from the cellar) I supported the whole on two 4-inch cut nails *h*. It was a problem how to hang the thing up without driving these nails into and thus disfiguring the wall; but this was soon solved. I filed a notch behind the head of each nail, and, after driving four pins *l* obliquely and downwards into the plaster wall, as shown, I made the nails perform the office of struts, so that they merely press against the wall, the silk threads *j* and *k* being in tension and kept



from slipping by the notches aforesaid. For scale pans, I took two pie dishes *n* and *p*, drilled three holes in each with the point of a pocket-knife blade, threaded them, and hung them over the notches in *a*, afterwards inserting ¾-inch lengths of match-wood *m* to keep the pans swinging freely. A white card *t*, neatly graduated and pasted to the upper leg of *a*, completed the scales. I balanced them by sticking pieces of cardboard to the back of *a* until the upper leg was approximately vertical.

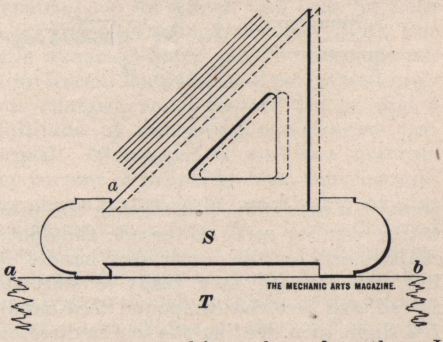
For the weights I bought 2 ounces (carefully weighed) of tinned wire about $\frac{1}{32}$ of an inch in diameter, for which I paid 3 cents. This I took into the yard behind the house, straightened out, and doubled over a wire nail driven into the fence; I then cut it in two, getting in this manner two separate 1-ounce weights, one of which I coiled up. The other I again doubled on itself and cut in two, thus getting two ½-ounce weights, one of which I coiled up as before. I went on in this way until I got down to two 15-grain pieces, each about 11½ inches long; one of these I twisted up to be used as one of the weights; the other length I divided, taking one-fifteenth of it for the 1-grain weight, two-fifteenths for the 2-grain, and so on. As a holder for the weights, I took an old cardboard letter-paper box *s*, and cut it down as shown, so as to get at the various weights easily. As a support for the weight pan *n* I used the lid of the above box cut up and built into a triangular frame *r* and pinned to the wall as shown.

The scales are quite steady, and, being suspended by four threads, as rigid as one could wish.

THE SIMPLEST OF SECTION LINERS.

Harry Bible, Denver, Col.

In The Mechanic Arts Magazine, February, 1899, in an article entitled "Drafting for the Patent Office," Mr. Palmedo says that, so far, no machine has been invented that usefully facilitates the work of section lining—that the best section liner is a trained eye and a skilful hand. In the main Mr. Palmedo may be right, but there are some men that, however much they practice, never



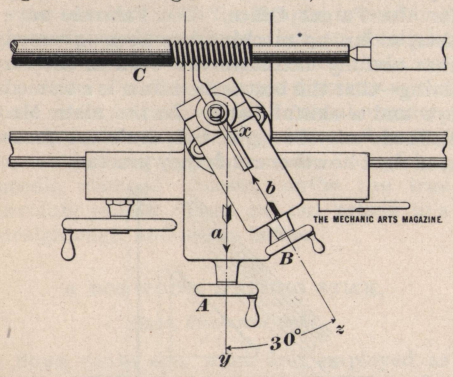
become expert at this work, and to them I can recommend the exceedingly simple device illustrated here. I can operate it just as fast as it is possible to handle the ruling pen, know that my spaces are equal, it saves my eyes from undue strain when

there is any considerable amount of section lining to be done, and it costs next to nothing. Referring to the sketch, *T* is part of the T square; *S* is the device, made of any suitable hard wood (I prefer white holly) or celluloid. Each edge of the device gives two spacings; thus, when held as shown, the point of the triangle enters the notch at *a*; when *S* is turned over end for end, the square edge of the triangle butts against *a* and the spacing is reduced. The opening in the other edge of *S* is made a different length, so that, in all, the one device gives four fixed spacings. To hold, let the thumb of the left hand rest on the T square and place the index finger on *S*, and the next two fingers on the triangle. To operate, press down on the triangle and push *S* to the right till it strikes at *a*; draw line; press on *S* and push triangle ahead; draw line, and so on.

A HELP IN SCREW CUTTING.

Hugh A. Wilson, Beloit, Wis.

I HAVE FOUND that the following method of cutting a screw thread in the lathe prevents dragging on the right-hand edge of the tool, and makes it an easy matter to adjust the feed. Turn the compound rest, as in the figure, at an angle of 30°; set the tool exactly right for cutting the thread, and run the



point of it up until it just touches the piece *C* that you are going to thread; then put a chalk mark on the lower feed-handle *A*. Run the carriage back ready to start the thread, and give the compound feed-handle *B* a slight turn, feeding the tool in direction of arrow *b*, until you get the proper cut; then drop in the feed-nut. When the tool reaches the end of the thread, run it out in direction of arrow *a* by means of the lower handle *A*, run carriage back for another cut, give *B* another slight turn, and so on till the thread is finished. By this method, one chalk mark —the one on *A*—is all you have to make; it is easy to get the feed required in direction of arrow *b*, and the tool does all the cutting with its left edge, and so dragging is prevented.

AN INEXPENSIVE DRAFTING TABLE.

Wm. P. King, Syracuse, N. Y.

BEING a student in mechanical drawing, but unable to afford a draftsman's table, I built one which serves the purpose tip-top. It is a rig that anybody could put together, so I send it as a contribution to Good Schemes, hoping that others will be glad of the idea. I took a $2'\,6'' \times 2'' \times \frac{1}{2}''$ strip of pine—*a* in Figs. 1 and 2—and nailed it to the wall about 3 feet from the floor. To this I attached a pair of 2-inch hinges, and swung the table from them, as shown. The table is simply a $2'\,6'' \times 2'\,0'' \times \frac{1}{2}''$ board, to the under side of which I fastened a toothed rack having six teeth of about $1\frac{1}{2}$ inches pitch. This rack, together with the adjusting leg *b*, which is simply a stick of pine hinged to block *c* fastened to the floor, enables the draftsman

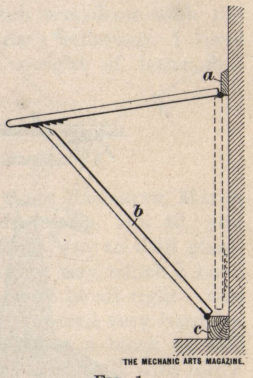


FIG. 1.

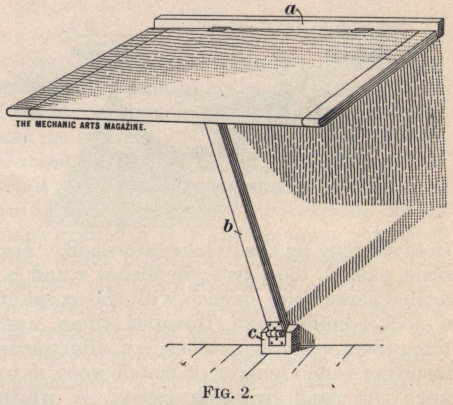


FIG. 2.

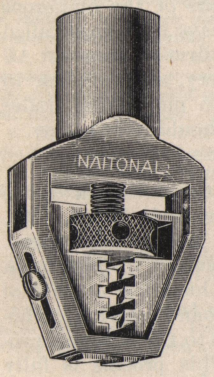
to vary the angle of the table at will. When not in use the table is folded down against the wall, as shown dotted in Fig. 1, with the leg *b* leaning against it, thus taking up very little space.

TRADE NOTES

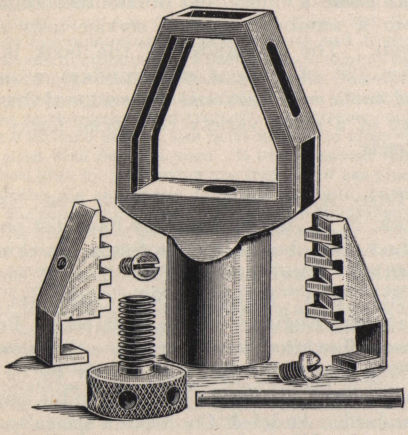
A NEW DRILL CHUCK.

THE ILLUSTRATIONS on this page represent the National drill chuck, manufactured by the Oneida National Chuck Co., Oneida, N. Y. The makers state in their catalogue:

"In placing the National skeleton drill chuck upon the market it is necessary that its workings and construction should be thoroughly understood, as its new and novel appearance will attract the eye of every machinist, and we are aware that it will be closely scrutinized by all interested in the advancement and improvement of tools.



"The construction of this drill chuck should commend itself to all. The flat body and open construction are just the opposite of all other chucks made; therefore, do not be prejudiced because in bringing it out we did not copy after others. This is original, as we do not believe in wearing wooden shoes because our forefathers did. It operates quickly with the thumb and finger until closed on drill; then a wrench is used to tighten. There is no projection to catch anything, and the flat, open body will not prevent it from drilling a round hole, but makes it easy to clean, light to handle and operate, substantial and durable, giving strength where necessary.



"We make for it the following claims:

"1. The grip to hold a drill is unequaled by any chuck upon the market.

"2. The construction is so simple that any person can put it together in one minute.

"3. The simplicity of construction and arrangement of parts causes the least wear, making it the most durable.

"4. It is the only chuck ever made in which all parts are exposed to view, so that any irregularity can be seen at once.

"5. It can be thoroughly cleaned in one-fourth the time of any other chuck.

"6. All unnecessary material is removed, leaving the strength where required and making it from one-third to one-half lighter than any other chuck made.

"7. It is the only chuck that is easily cleaned, being so open that the dirt will not stay in, and can be blown or brushed out without removing the parts.

"8. It is perfectly balanced and made in all sizes—large and small.

"9. It is the only chuck that is strong and powerful, equally adapted for either light, swift, or heavy work."

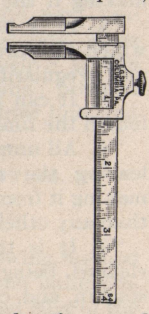
HAND-POWER MODEL DYNAMOS.

THE ELBRIDGE ELECTRICAL MFG. CO., Elbridge, N. Y., inform us that they have lately put on the market an improved Model dynamo, one for direct, and one for both direct and alternating, currents. With this little dynamo, water may be decomposed, incandescent lamps lighted, permanent magnets charged, small motors driven, and a multitude of interesting experiments performed. It may also be used as a motor on any current of proper voltage, thus furnishing power to run light machinery, such as sewing machines, fans, etc. It was designed especially for the use of schools and students of electricity, and to them is invaluable, since it gives the whole theory of the modern dynamo and follows in construction every detail found in large generators. It is made for actual use, all parts being of the best material and put together in the most substantial manner. The armature core is laminated and wound with double-covered wire; its shaft is made of steel and runs in

brass bearings. The commutator has 16 bars, ample brush contact, and will wear for years. All machines are shunt-wound unless otherwise ordered.

TWO USEFUL TOOLS.

E. G. SMITH, Columbia, Pa., is making what to the machinist should prove two very useful tools—the "Which Way" level, and the "Columbia" caliper. The level, as will be seen from the accompanying full-size illustration, is designed to tell you immediately "which way" your work is out of level. Under an accurately ground and polished glass cover there is a bubble of air in liquid; upon a perfectly level surface this bubble floats in the center of the disk, as shown; when resting upon a surface that is out of level, the bubble will move towards the circumference of the disk, always traveling towards the highest part of the surface, and thus indicating which way the work is out.



The caliper tells you the size of the work, and also how much too large or too small. It reads both inside and outside measurements without mental calculation, and is graduated to 16ths of an inch, with a vernier to read to 32ds, 64ths, and 128ths.

BOOKS AND CATALOGUES.

FIRST LESSONS IN LINEAR PERSPECTIVE. By Frederic R. Honey, Ph. B. Size, 9 in. × 12 in.; cloth cover. Published by Charles Scribner's Sons, New York. Price, 80 cents.

This book consists of twenty complete lessons in linear perspective. The first ten lessons were published separately some months ago and reviewed in the July, 1898, number of this magazine. The additional lessons that complete the work comprise the drawing in perspective and in various positions of prisms, pyramids, cylinders, the Greek and the Latin cross, flights of steps, hexagonal and fluted columns, groined arches, and a room furnished and hung with pictures. There is also a lesson on geometry as applied to perspective. The book contains, in all, thirty-eight full-sized plates, all most excellently done. In his descriptions Mr. Honey is as thorough as the English language will permit him to be, and he does not allow a single point to pass unexplained, for which reasons the book is worthy of great popularity with beginners, and should prove of much practical use to teachers also.

ONE OF THE most complete tool catalogues issued is that of Montgomery & Co., 105 Fulton street, New York. The book contains over 500 pages, is profusely illustrated, and gives full particulars of the numerous tools and devices that have been most called for in the course of the firm's business. All users of tools, machinery, and supplies, in whatever branch of the mechanical trades they may be engaged, should have a copy.

THE CARBORUNDUM CO., Niagara Falls, N. Y., have handed us their No. 2, 1898, catalogue; size, 6½ in. × 8 in.; 60 pages. The first part of this book is devoted to an exceedingly interesting historical account of the early methods of manufacturing carborundum, which lead up to the Acheson process as now used. This process is fully described, and is illustrated with reproductions of photographs taken in the above company's works. The chapter includes information regarding the properties and uses of carborundum, especially as compared with those of emery, and the results obtained from a number of actual service tests are given. The remainder of the book is a price list of various carborundum wheels and tools, with sectional dimensioned drawings of a great variety of special forms of wheels.

THEO. AUDEL & Co., 63 Fifth Ave., New York, N. Y., tell us that they have just published two books by Professor Hawkins, entitled "Hawkins' New Catechism of Electricity" and "Hawkins' New Catechism of the Steam Engine." Price, $2.00 each. Professor Hawkins' works are so well known among engineers that any review by us is unnecessary, the books being up to his usual standard. Audel & Co. make a specialty of selling their publications on easy payments, thus placing them within the reach of all. Any one wishing to inform himself about the practical management of steam plants, and the practical applications of electricity, will do well to obtain copies of the above works.

ANSWERS TO INQUIRIES

NOTE.—*Address all letters containing questions to be answered in this department to* THE MECHANIC ARTS MAGAZINE, *Scranton, Pa.*

1. Put this address both on the envelope and at the head of the letter.

2. Only questions of general interest to our readers will be answered.

3. No questions will be answered by mail.

4. Drawings or sketches accompanying questions should be made on a separate sheet of paper, and should be drawn as clearly as possible.

5. The names and addresses of the writers must accompany the letters, or no attention will be paid to them. Unless otherwise requested, we will publish only the initials and address of the writer.

6. Reference to inquiries previously answered should give date of issue and number of question.

7. Any book not out of print and for sale by regular dealers may be ordered through the Magazine.

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(81) Herewith I send you a sample of tracing linen that will not take the ink. What is the matter with it, and what shall I do to it to make it work?

J. A., San Francisco, Cal.

ANS.—We have tested the linen and find that it takes ink perfectly. Perhaps there is something wrong with the ink you are using.

***

(82) To settle two arguments, kindly answer the following: (*a*) Does illuminating gas ever freeze in the pipes? (*b*) Is it possible for a person to "scull" a boat without the aid of an oarlock of some description?

F. H. L., Scranton, Pa.

ANS.—(*a*) Illuminating-gas pipes become filled with frozen vapors which form part of the gas, and the gas pipes are then said to be frozen. Of course, the gas itself does not freeze in the pipes, but the vapors accompanying the gas condense and freeze. Unsuccessful attempts have been made to remove the moisture by preliminary freezing in tanks. Another process is to dry by sulphuric acid, which is efficacious as far as the water is concerned, but extreme cold, even with such process, has been known to close up the pipes with frozen benzol. It would appear that the best plan for preventing the freezing of gas pipes is for the gas companies to inject alcoholic vapor into the gas at the works. This apparently prevents the freezing both of the water and the benzol. "The effect of this alcohol vapor," says a renowned German scientist, "is shown in the fact that if, by the action of the cold, separations of water and benzol occur, the alcohol vapor carried along also separates, whereby the freezing point of these separated condensations of water and benzol is forced down so much that they will not congeal even at our lowest temperatures in the winter. They remain in liquid condition, and thereby can freely flow back in the main conduits, where they collect in the condensing pots." (*b*) There are two meanings to the word *scull;* in other words, there are two ways of sculling a boat. In one, the oarsman stands up, and, with one oar used over the stern, propels the boat by imparting to the oar a twisting motion from side to side, as if in imitation of the action of a screw. In the other, two long spoon-bladed oars, or sculls, are used, and the sculler sits upon a seat near the center of the boat, and rows with both hands at once. resting the oars in oarlocks, which are usually outrigged. The sculler's seat may or may not be a sliding one. In sculling with one oar over the stern, the oarlock is an assistance, but is not absolutely necessary.

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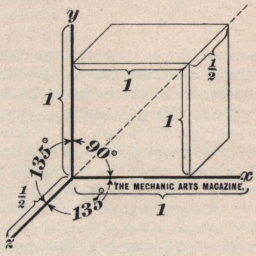
(83) (*a*) What is "cavalier" perspective, as mentioned in THE MECHANIC ARTS MAGAZINE, February, 1899, article entitled "Drafting for the Patent Office"? If a full answer to this question would occupy too much space, kindly refer me to a book on the subject. (*b*) Also, give me the names and prices of good works on the following subjects: mill engineering, bridge engineering, and mining engineering. I have no objection to advanced mathematics in any of these works.

J. A. P., Providence, R. I.

ANS.—(*a*) *Cavalier* perspective is one of various methods of making a perspective representation of an object by means of parallel projection, as against polar projection, used for true perspective. The methods referred to all consist in drawing the outlines of the object parallel respectively to three axes x, y, z, assumed in the plane of the drawing, and representing the angular parallel projection of three orthogonal axes imagined within the body to be drawn. The number of such imaginable projections is very great, but, in practice certain distinct ones are used, one of which is the so-called cavalier perspective. In this, the angle between x and y is 90°; the other two angles are each 135°, and the scales employed for the axes are relatively as $x : y : z = 1 : 1 : \frac{1}{2}$. (*b*) Rankine, "Machinery and Mill Work," $5.00; "The Practical American Millwright and Miller," by David Craik, $3.50; "Theory and Practice in the Designing of Modern Framed Structures," by Johnson, Bryan, and Turneauve, $10.00. There is no complete publication in mining engineering. Geo. G. Andre's "Practical Treatise on Coal Mining" (2 vols. $15.00), and G. C. Greenwell's "Coal Mining" ($6.00) are standard works, but are decidedly English. The foregoing works can be obtained through The Technical Supply Co., Scranton, Pa.



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(84) (*a*) Please tell me how to calculate the amount of water necessary to condense the steam from any engine, the condenser being either jet or surface. (*b*) How much power can I get from an impulse waterwheel 52 inches in diameter, fitted with Pelton buckets, under the following conditions: diameter of jet, ¼ inch; water pressure, 80 pounds, from the street main through a ½-inch pipe 150 feet long; number of revolutions per minute, 250.

J. T. M., New Albany, Ind.

ANS.—(*a*) A very simple rule for calculating the amount of condensing water, with as great a degree of accuracy as is usually required, is the following: Divide 1,000 by the difference between 110 and the temperature of the condensing water; multiply the weight of steam to be condensed by this quotient, and the result will be the weight of the condensing water required. (*b*) Owing to frictional losses, you

could not get more than a small fraction of a horsepower, possibly $\frac{1}{10}$ horsepower, from the water that would flow through the ½-inch pipe under conditions you have named. It would be impossible to get a speed of 250 revolutions per minute with a 52-inch wheel using the water from the ½-inch pipe.

***

(85) Kindly show how to lay out an elbow 3 feet in diameter, made of ⅜-inch plates. I want this layout made by the right-angular method.

R. Q., Lorain, Ohio.

ANS.—In order to obtain a "layout," or pattern development, for any object, it is necessary first to produce a correct representation or drawing of the object in one or more positions; or, the same results may sometimes be obtained by the use of various sections taken on different planes. The object in question is a four-pieced square elbow, and, before proceeding to describe the pattern, it will be well to illustrate a simple method of finding the line of intersection, or the miter line. This method is applicable to elbows having any number of pieces, and, by slight modification, to elbows of different angles. In Fig. 1 the angle *a b c* is drawn by the use of the T square and 45° triangle; with a radius nearly equal to *a b*, and with *b* as center, describe the arc *e f*; this arc is then divided, by spacing, into a number of parts—*one less than the number required in the desired elbow*—and a line drawn from *b* through the division in the arc nearest the line *a b* will be the correct miter line for our elbow. We may now proceed directly with the development of the pattern. Place a half section of the elbow *g h i*, as shown, on *a b*. Divide the half circle *g h i* into a convenient number of equal parts, and draw perpendiculars to *a b* from each of these points, continuing them until they cut the line *b d*. Extend the line *a b* indirectly towards *j*, and, starting as near *b* as is convenient, set off twice as many spaces as there are in the half section of the elbow. From each of these points erect perpendiculars, as shown. Now, with the T square, project each intersection of the line *b d*, with the lines drawn from the half section, on to the perpendiculars drawn from *b j*. It will be readily seen that the irregular curve *A B C* may be produced by tracing through the diagonally opposite corners of the small rectangles thus formed. The curved line *A B C* is the correct pattern for the "cut" of the elbow; and, as matters relating to the length of throat required are optional with the mechanic, it will be seen how these lengths may be changed without affecting the angle of the elbow. The four-pieced elbow shown may be cut without waste of stock by reversing the patterns for the sections as shown in Fig. 2, the curve being the same in each case. In large elbows of the size mentioned in the question, it will be found practicable to make up the blank from two or more sheets of metal, allowing the seams to be in the position shown by the dotted lines in the central portion of the figure. The dotted lines at each side of the blank represent the stock added for laps, which is of course a matter of choice with the mechanic. While the same methods of development are made in all elbows of the class mentioned, there is, in this particular case, an element that would affect the practical working of the method, and that is, the thickness of the metal worked. Boilermakers are accustomed to add seven times the thickness of the material used to the length actually needed for the circumference of the desired circle, in order to bring the diameter to the correct size when the work is formed up. Now, it is obvious that, if we add seven times the thickness of the metal (which would be 2⅝ inches in the present case) to one end of our pattern sheet, it will not be correct, as this extra stock should be distributed through the entire circumference of our elbow, and the pattern should also partake of this increase. To make allowance for this property of the material, the following method may be used: On the line *b j*, Fig. 1, add the measurement required for the extra thickness of the stock, at *j k*; with a radius equal to *l k*, and with *l* as center, describe an arc cutting the perpendicular extended from *C*; from this point of intersection draw a line to the point *l*, and extend the dotted lines in the manner indicated in Fig. 1; make *l A'* equal to *l A*, and continue through each perpendicular in like manner. The curve *A' B' C'* may then be produced, which will be the correct pattern for the elbow required. Fig. 3 shows the usual method of laying off edges for elbows made of heavy metal, the stretching for the flanges being done while the metal is hot. The rivets are also set while hot, and are placed to one side of the intersection line, giving the work a finished appearance.

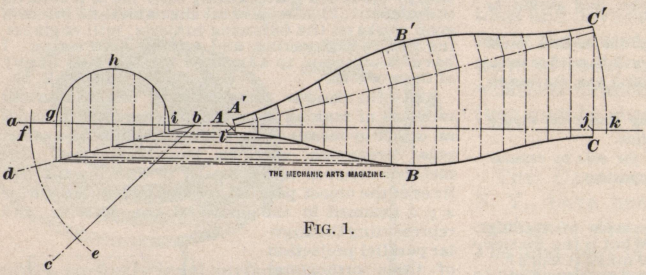

FIG. 1.

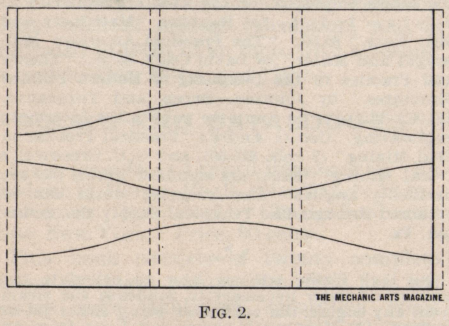

FIG. 2.

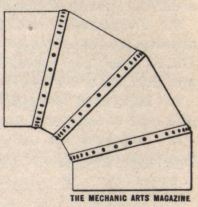

FIG. 3.

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(86) (*a*) Please explain the method of procedure when designing the foundation for an anvil that is to receive the blows of a falling weight or steam hammer. For example, what must be the area of the foundation for an anvil that is to receive the blows of a 500-pound weight after falling 20 feet? The earth in which the foundation is to be built will carry a static load of 4,000 pounds per square foot.

(*b*) If a water-service pipe from street main to front cellar wall is ¾ inch in diameter, and is enlarged to 1 inch diameter inside of cellar, carried thus for 50 feet to rear of building, then continued with the same diameter to the third floor, branches being taken off for fixtures at each floor, all 1 inch in diameter, how much more water can be obtained than if ¾-inch piping were used throughout the house? Assume any convenient water pressure and total length of piping. X.

ANS.—(*a*) A rational solution of this problem involves the use of a number of factors whose values cannot be determined with sufficient accuracy to make the results of much practical value; it is, therefore, customary to depend on simple formulas based on practical experience. The following formulas for calculating the weight of foundation to be used under the anvil block, and the probable pressures on the earth under the foundations, are given by a good authority:

Let G = weight of the falling parts of the hammer;
H = height of fall, in feet;
W = weight of material in foundation;
P = total pressure on earth under foundations.

Then, for a simple falling weight—for example, a steam hammer in which steam does not act above the piston to increase the force of the blow—

$$W = 1.8\,H\,G,$$

for hammers used in forging iron; and

$$W = 2\,H\,G,$$

for hammers used in forging steel. For steam hammers in which live steam acts above the piston, so as to increase the force of the blow, make the weight of the foundation 30 per cent. greater than the value obtained by the above formulas. The total pressure on the earth on which the foundation rests is given by

$$P = 9\,G\,H + W \text{ to } 18\,G\,H + W,$$

for hammers used for forging small billets;

$$P = 18\,G\,H + W \text{ to } 28\,G\,H + W,$$

for hammers used for welding piles of bars into blooms; and

$$P = 28\,G\,H + W \text{ to } 38\,G\,H + W,$$

for hammers used for forging steel. (*b*) There is so much uncertainty regarding the frictional losses in the different pipes and fittings of such a system that we cannot make an estimate of the gain in flow that would have any practical value.

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(87) I want to know how to build an oven that will dry bricks quickly. The bricks are made of sawdust and coal mixed together and pressed into $7'' \times 4'' \times 3''$ blocks, perforated with a number of holes. When pressed, each brick contains about 4 ounces of water, which has to be dried out. The oven I am now using is about 40 feet long, 4 feet wide, and 5 feet high, and will hold about 4,000 bricks. It is built of brick, and is heated with fifteen 1¼-inch steam-pipe coils. The bricks are placed on thin boards on "buggies" similar to those used in brickyards; but it takes 2 days to do the drying. If you can tell me of some kind of oven that will hold from 400 to 500 bricks, and dry them quickly, I shall appreciate it very much.

N. M. D., Mt. Oliver, Pa.

ANS.—You will understand that heat is not the dryer; heat only helps the air to absorb moisture from the bricks. The air is the real drying agent, and when the air is nearly saturated with vapor by absorbing the moisture from the bricks, you must remove this air from the kiln and replace it with more *dry* air; otherwise, the air in the kiln, although hot, will not dry the bricks. What you need is an arrangement for circulating very dry air through the kiln. This can be accomplished by having a slatted floor, and a space of about 2 or 3 feet under the floor, and a number of steam pipes in the space. Then you require an opening to allow fresh air to enter the space under the steam pipes and another hole in the ceiling to allow the moisture-laden air to escape up through a ventilating shaft in the roof. Thus you will have a constant stream of hot, dry air passing up through the bricks. Place a damper in the vent stack and you can control the current easily.

***

(88) On an incandescent-lighting circuit, run on the three-wire system, will both the ammeters give the same reading when there are more lights on one side than on the other? For instance, if there are two hundred 16-candlepower lamps on one side, and one hundred on the other, will one ammeter show about 100 amperes, and the other about 50, or will they both show about 75 amperes?

C. F. I., Scranton, Miss.

ANS.—The two ammeters, being placed in the outer conductors, will register independently of each other the current passing through those conductors. In the case above mentioned, therefore, the ammeters would indicate 100 amperes and 50 amperes, respectively.

***

(89) (*a*) To settle an argument, kindly answer the following question: Is the over stroke of a locomotive engine more powerful than the under stroke? By this I mean, can a heavier load be started when the crank-pin is vertically *above* the axle than when it is vertically *under* the same? (*b*) Would air at a temperature of 80° become cold enough to freeze water, if it were driven by an air pump at a high rate of speed? R. E. P., Brown's Valley, Minn.

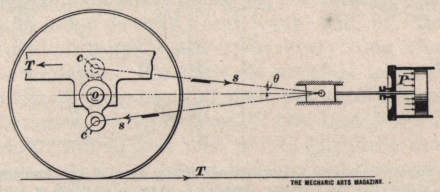
ANS.—Let

P = total pressure on piston;
T = tractive force;
R = radius of driver;
r = radius of crank;
θ = angle of the connecting-rod when the crankpin is at c above the axle.

Then, $\frac{P}{\cos\theta}$ = pull s exerted by the connecting-rod on the crankpin. Taking moments about the center o of the axle, the moment of s is

$$s \times r\cos\theta = \frac{P}{\cos\theta} \times r\cos\theta = Pr,$$

and the moment of the rail pull T is TR. The other forces acting on the driver and axle are the weight



supported and the reaction of the frames. Evidently, however, the lines of action of these forces pass through the center o, and they have therefore no moment about o. We have, then,

$$TR = Pr, \text{ or } T = \frac{Pr}{R}.$$

Now, when the crankpin is at c', $s' = \frac{P}{\cos\theta}$, the moment of s' is $\frac{P}{\cos\theta} \times r\cos\theta = Pr$, and $T = \frac{Pr}{R}$, as before. The rail pull T is just equal and opposite to the drawbar pull, since these two forces are the only horizontal external forces acting on the locomotive. It follows, therefore, that the same load can be started, whether the pin is vertically above or below the axle. (*b*) No; the temperature of the air would be increased.

***

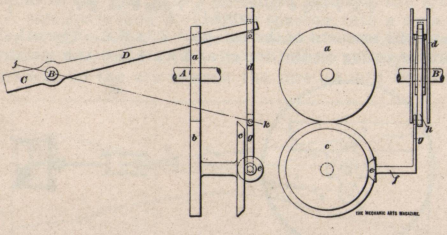
(90) With reference to the gasoline engine illustrated in HOME STUDY MAGAZINE, January, 1899, article entitled "The Gasoline Engine," kindly answer the following questions: (*a*) Would it be

practicable and economical to regulate the speed by attaching the governing mechanism to the needle valve *F*, leaving the volume of air taken in constant for all loads. (*b*) Would it not be difficult, on a cold day, to get the engine to start, with cylinder head *Y* and pipe *G* cold, on account of the gasoline evaporating slowly? (*c*) What is the ratio between the volume of liquid gasoline and its vapor at atmospheric pressure? (*d*) Are any of the illustrated features of the above mentioned engine patented, that you know of? W. C. B., Litchfield, Ill.

ANS.—(*a*) The method of governing proposed is used on some forms of gas and gasoline engines. In case the load is practically constant and near the full capacity of the engine, the regulation of the gas supply alone, leaving the air supply constant, is probably the best method that can be adopted. If the load varies through a wide range, however, the gas might be cut off entirely at light loads, and a considerable fluctuation in speed would result; in this case it is considered better practice to regulate the flow of the mixture of gas and air, as is done in the engine under consideration. (*b*) We believe there is some special method of starting the engine under these circumstances. See HOME STUDY MAGAZINE, February, 1898, article entitled "Gas Engines." (*c*) We are unable to find any information on this point. The following statement, quoted from a recently published book, may be of interest to you: "The vapor of commercial gasoline at 60° F. is equal to 130 volumes of the liquid." (*d*) Several patents have been issued to the makers of this engine, and they probably cover all novel features.

***

(91) I desire a general solution of the following problem: Referring to enclosed sketch, if 1,000 pounds is applied to shaft *A*, what percentage of it will be transmitted through the mechanism, and remain as useful effort to lift arm *C* of the lever fulcrumed on shaft *B*, the force passing through the gears *a* and *b*, bevel gears *c* and *e*, shaft *f*, crank *g*,



connecting-rod *h*, crosshead from arm *d*, to position shown by the center line *jk*? Arm *C* carries a uniformly distributed load of 5,500 pounds; arm *b* is seven times as long as arm *C*.

S. E. S., White Plains, N. Y.

ANS.—A general solution of this problem would be of no practical use to you, because you evidently do not understand the effect of frictional resistances upon the efficiency of machinery. In another part of this number you will find the first part of an article entitled "Sliding Friction"; read and thoroughly understand this, and then study the second part when it appears in the May number; you will then be in a position to solve the above problem.

***

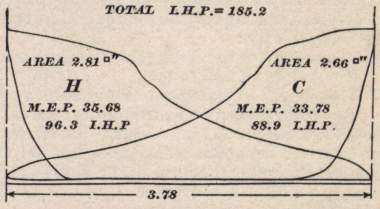
(92) (*a*) Please tell me how to make a paste suitable for mounting a gelatine photographic print face down on glass. (*b*) Can you tell me of a book on the coloring and mounting of photographs on glass?

F. S. D., Berkley, Mass.

ANS.—(*a*) Use a thin solution of plain gelatine. Soak the gelatine in cold water over night, and, after pouring off the surplus water in the morning, warm the swelled gelatine over a water bath; and, when melted, dilute gradually with hot water until the gelatine has the consistency of thin cream. Warm the glass on which the print is to be mounted, and coat it with the warm gelatine paste; then, when glass is cool, squeeze the wet print into contact with the gelatine surface and leave to dry. (*b*) We know of no book devoted exclusively to the coloring of photographs on glass.

***

(93) Enclosed find cards of engine of which I have lately been given charge. (*a*) What is the horsepower of the engine? (*b*) Tell me all you can about the engine from the cards. (*c*) There is a snapping noise in the cylinder, as though water were



siphoned over into it from the boiler; but it is the same whether the water is high or low. Can it be caused by the piston rings, or what do you think is the trouble? I should have mentioned that the steam piping is 6 inches in diameter.

W. B. A., Torrington, Conn.

ANS.—(*a*) The horsepower, calculated from the data given on the card, is 185.2 I. H. P. Are you sure you have given the correct scale for the indicator spring? We have never before heard of a spring having that scale. (*b*) The general performance of the engine, as indicated by the cards, is fairly good, and it is probable you will find it difficult to make any change that will improve the working of the engine to any great extent. The most serious faults shown by the diagrams are the following: The steam line falls considerably before cut-off begins, showing that the steam is throttled; the cause may be that the steam pipe is too long, or there may be some obstruction, such as a number of bends in the pipe, a partly opened valve, or restricted steam ports. Cut-off takes place later on the head than on the crank-end; the result is that about 7½ horsepower more work is done in the head than in the crank-end. (*c*) It is probable that the noise is caused by the piston rings. It often happens that, when the rings enter the counterbore, the pressure of the steam closes them, causing the snapping sound about which you speak.

***

(94) What is the process by which ginseng roots, burdock roots, and yellow dock are prepared for the market? This question is perhaps a little out of your line, but I thought you could give me some information, or, at any rate, tell me where I could get the information. R. H. S., Trumansburg, N. Y.

ANS.—The roots of these three plants are dug out in early autumn, cleaned, and dried.

***

(95) What, in your opinion, is the best kind of dry closet, for use where there is no water?

C. M. G., Georgetown, Ohio.

ANS.—The best closets for use in places where water cannot be had for flushing purposes, is the earth closet. It should, of course, be set outside the main building. Earth is a excellent deodorizer, and an earth closet—which is flushed with earth, so to speak—is considered by sanitarians to be the best where water cannot be had.

SELF HELP

WORK, THE WATCHWORD OF SUCCESS.

"WORK and be thorough," is our counsel to men who seek to rise by self-improvement.

There is no want of desire on the part of most persons to arrive at the results of self-culture, but there is a great aversion to pay the inevitable price for it—hard work. Dr. Johnson held that "impatience of study is the mental disease of the present generation," and the remark is still applicable. We may not believe that there is a royal road to learning, but we seem to believe very firmly in the "popular" road. In education we invent labor-saving processes, seek short cuts to science, or learn French and Latin "in twelve lessons" or "without a master." We resemble the lady of fashion, who engaged a master to teach her on conditions that he did not plague her with verbs and participles. We get our smattering of science in the same way; we learn chemistry by listening to a short course of lectures enlivened by experiments, and when we have inhaled laughing gas, seen green water turned red, and phosphorus burned in oxygen, we have obtained our smattering, of which the most that can be said is, that, though it may be better than nothing, it is yet good for nothing. Thus we often imagine we are being educated while we are only being amused.

The acquirement of bits of information, without study and labor, is not education. It occupies but does not enrich the mind. It imparts a stimulus for the time, and produces a sort of intellectual keenness and cleverness; but without an implanted purpose and a higher object than mere pleasure it will bring no solid advantage. In such cases knowledge produces but a passing impression—a sensation, and no more; it is, in fact, the merest epicureism of intelligence—sensuous, but certainly not intellectual. Thus the best qualities of many minds, those which are evoked by vigorous effort and independent action, sleep a deep sleep, and are seldom called to life, except by the rough awakening of sudden calamity or suffering which, in such cases, comes as a blessing if it serves to rouse up a courageous spirit that, but for it, would have slept on.

Accustomed to acquire information under the guise of amusement, people will soon reject that which is presented to them under the aspect of study and labor. Learning their knowledge and science in sport, they will be too apt to make sport of both; while the habit of intellectual dissipation, thus engendered, cannot fail, in course of time, to produce a thoroughly weakening effect both upon their mind and character. "Multifarious reading," said Robertson of Brighton, "weakens the mind like smoking, and is an excuse for its lying dormant. It is the idlest of all idleness, and leaves more impotency than any other."

The evil is a growing one, and operates in various ways. Its least mischief is shallowness; its greatest, the aversion to steady labor which it induces, and the low and feeble tone of mind which it encourages. If we would be really wise, we must diligently apply ourselves, and confront the same continuous effort that our forefathers did; for labor is still, and ever will be, the inevitable price set upon everything that is valuable. We must be satisfied to work with a purpose, and wait the results with patience. All progress, of the best kind, is slow; but to him who works faithfully and zealously the reward will, doubtless, be vouchsafed in good time. The spirit of industry, embodied in a man's daily life, will gradually lead him to exercise his powers on objects outside himself, of greater dignity and more extended usefulness. And still we must labor on; for the work of self-culture is never finished. "To be employed," said the poet Gray, "is to be happy." "It is better to wear out than to rust out," said Bishop Cumberland. "Have we not all eternity to rest in?" exclaimed Arnauld.

Work, the watchword, calls from everywhere for men to equip themselves with knowledge, for the struggle of life. Progress in knowledge should be the aim of old and young; the needs of the times demand it. Man was designed for work, not for ease.

Most people want the results of self-culture without the work. Knowledge acquired without study and labor is not education. Those accustomed to learn easily will reject that which is accompanied by study and labor. We should desire to rise by study and hard work, whose results will endure the tests of time and use.

FROM FARMER BOY TO COLONIAL GOVERNOR.

THE American farm has given this nation and the world at large some of the most illustrious men that have within the century just closing adorned the earth and strengthened the race by their presence, influence, and ability.

Nature's true noblemen have, from Washington to Lincoln, and from Lincoln to Garfield, come from the quiet, charming, virtuous country homes of the land, to lead Americans in every social struggle, and in every national crisis, to victory and to renown.

Witness the following narrative of a noble soul's success, the triumph of a brave farmer's boy, the march from the plow to the highest honors a grateful nation can bestow, the governorship of an imperial domain, the Philippine Archipelago. This historic group of fourteen hundred islands, with ten millions of people, is, for General Merritt, its first governor, as it is for the United States of America, a new field. Appointed to this high office, General Merritt is not only honored, but has before him duties that will demand the display of all the qualities of greatness he has already shown, and others that he will, no doubt, disclose. Said General Banks, "Responsibility educates men." General Merritt has not only to fight, but, by wisdom, to pacify, organize, and rule these people, for their own good and the honor of the United States.

Wesley Merritt, born in New York City, in 1836, was graduated at West Point, April 5th, 1862; took part in Stoneman's raid about Richmond, and had command of a cavalry brigade; he was breveted major for valor at Gettysburg, after having received successive brevets for bravery at Yellow Tavern, Hawes' Shop, and Winchester. At Five Forks, he was, for courage, breveted brigadier- and then major-general in the regular army; and, later, was commissioned major-general. He did good service on the frontier till 1882, when he was put in charge of West Point. He afterwards served again at Fort Leavenworth.

The following interesting facts taken from "The New York Herald" and "The Army and Navy Journal" show the inherent power and extraordinary gifts of this illustrious soldier. Merritt won fame and honor as Sheridan's chief officer in the great battles of the Civil War. He was an unrelenting warrior, once fighting nine battles in ten consecutive days.

His father, John Willis Merritt, was a New York lawyer. When Wesley was four years old, his father, having a large and increasing family, abandoned law for agriculture, and bought a farm at "Looking-Glass Prairie," near Belleville, Illinois, not far from St. Louis. The boy Wesley attended a school of Christian Brothers at Belleville. He worked for three years on the farm with his brothers, raising corn and pork.

Young Merritt often drove the farm team seventeen miles to town, getting fifteen cents a bushel for his corn. There was little money then in circulation, and pasteboard checks were used instead. At sixteen, Governor Bissell secured him a cadetship at West Point.

"Up to that time," said Merritt, "I had no idea of ever becoming a soldier. My ambition was to be a good lawyer and politician, and enter public life. I believed that my forte lay in discussion and public speaking. However, when my father pointed out the great advantages of a West Point education, a careful consideration of the subject convinced me of its wisdom. I accepted his views and went to West Point. The course of study was for five years. I got along very well. I did not stand high in my class except in English, and was rather slow in mathematics. I think I was in the only class ever graduated from that institution which took a course occupying full five years."

The farms of America make of the youths who toil thereon the most resourceful and self-reliant men in the world.

"Aim at the highest prize: If there thou fall,
Thou'lt haply reach the one not far below."

CHEERFULNESS AT WORK.

NEVER did Thomas Carlyle write nobler lines than these: "Give us, O give us, the man who sings at his work be his occupation what it may! He will do more in the same time, he will do it better. One is scarcely sensible to fatigue whilst one marches to music. Wondrous is the strength of cheerfulness, altogether past calculation its powers of endurance."

ANDREW CARNEGIE.

A Notable Example of Self-Achieved Success.

THE subject of this sketch was born on the 25th of November, 1837, in Dumfermline, near Edinburgh, Scotland. His father, William Carnegie, was a master linen weaver. Andrew received his early education from his mother, but at the age of eight he was sent to the local schoolmaster. Scarcely had he started on his studies, however, when his father was deprived of work through the introduction of steam power. So the family left Scotland and came to Allegheny City, Pa.

At the age of twelve, Andrew did his share towards the support of the family by working as a bobbin boy in a cotton factory, at $1.20 per week. By constant study and observation he learned to run a small steam engine in the cellar of the factory, and afterwards to act as clerk for his employer.

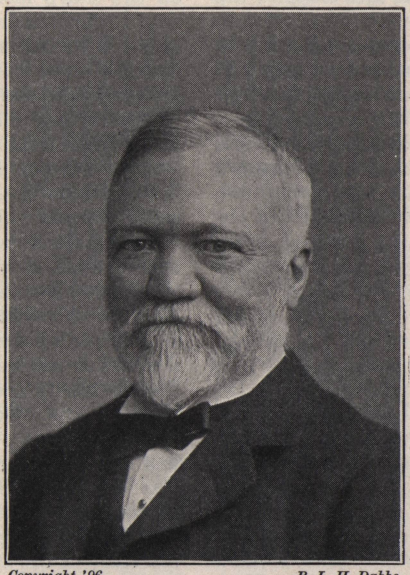
At the age of fourteen he obtained a position as messenger boy for the Ohio Telegraph Co., where he finally became an operator at $25 per month. This was a welcome change, as the death of his father had left him the sole support of the family.

His next position, as an operator, was with the Pennsylvania Railroad Company. Here he rapidly mastered the details of train despatching, and perfected a system so superior to all existing methods that he was promoted, first, to the position of secretary to the superintendent, and afterwards to the superintendency of the western division, at the age of twenty. He was instrumental in introducing the Woodruff sleeping cars, and from his investment in them realized the beginning of his fortune.

In 1861, he rendered good service to the Government, in charge of the military railroads and telegraphs, but his next business venture was in the famous Storey Farm, Oil Creek, Pa., which he bought, with two others, for $40,000. Its value soon rose to $5,000,000, and one year's dividend alone amounted to $1,000,000.

After disposing of his interest in this business, he started the Keystone Bridge Works, of Pittsburg, Pa. This was soon followed by the Union Iron Mill and the Edgar Thompson Steel Mill. After buying out his rival, the Homestead Steel Works, and building other great plants, he became, and has remained, the largest iron and steel manufacturer in the world, employing 25,000 men, whose monthly wages aggregate $1,125,000.

The reasons for his success are not hard to find. Hampered by poverty and hardships, but employing all his available time in self-improvement, he was bound to rise. He gladly acknowledges that the education which enabled him to advance was gained by the study of books loaned him by a Colonel Anderson, of Allegheny, who opened his library to working boys and men on Saturdays. In a like spirit of philanthropy, Mr. Carnegie has given large sums to various cities for the foundation of free libraries. His "luck" may be analyzed as the possession of a clear mind, a strong will, the ability to see opportunities, the ambition to take quick advantage of them, and the power of will to "stick" until all difficulties were overcome.



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Andrew Carnegie.

In the face of his experience—and he is only one of many—no man should feel discouraged because his lot is cast "at the bottom of the ladder." Garfield has said, "Poverty is uncomfortable, as I can testify; but nine times out of ten the best thing that can happen to a young man is to be tossed overboard, and compelled to sink or swim for himself. In all my acquaintance I never knew a man to be drowned who was worth the saving."

A PRINTER'S SUCCESS.

Persist, if thou wouldst truly reach thine ends,
For failures oft are but advising friends.

From a printer's apprentice, carrying his dinner in a napkin and working day and night to get a living, Robert Bonner rose to be the owner of millions and a leader in many departments of life. He did not get his fortune by any trick or streak of luck, but by steady, honest effort, careful saving, and prudent investment. Bonner might be called the father of advertising. He saw its value; he dared heights of boldness in calling attention to his wares that amazed his contemporaries. He was always the champion of right, and, at an early age, allowed himself to be turned out of school for his part in defending a boy whom he knew to be innocent. The quickest typesetter in the office of the Hartford "Courant," he, on one occasion, set up the President's message, at the rate of 1,700 ems an hour, to enable that paper to get the message out in advance of other papers.

From Hartford he went to New York, and, in the broader field, soon conquered his way to a place among the prominent, leading, and successful business men of the metropolis. He sometimes invested every dollar he had in bringing his enterprises before the people, but would not get into debt, and always refused to accept credit. When he began on the Hartford "Courant" he got his board and lodging, $25 for the first year, $35 for the second, and $45 for the third. Never having had any school advantages to speak of, he endeavored to learn all he could from the copy he set up. He always saved something. Never accumulating money for the sake of getting rich, he went on the principle of living always within his income, and so his bank account grew. One day after he went to New York he found that he had $70 ahead, and with this opened a bank account, keeping up the deposits until they amounted to $1,000 a week. When he bought the New York "Ledger" it was a little financial sheet. Bonner made it a family journal and employed some of the most noted writers in the country to contribute to it. He paid these contributors such extravagant prices for their work that all the newspapers of the country ridiculed his lack of judgment without considering that he was getting his money's worth out of them in free advertising. So he became immensely rich. He attributed his remarkable success to perseverance.

A GOOD MANNER.

THERE is something really magical about what is termed "a good manner" that impresses itself upon even a stranger. Many a man has "won life's battle" largely by this weapon.

A young man left his Green Mountain home at the age of twenty, and started for the wide West, to seek his fortune. He was used to poverty and hardship, and it did not dishearten him to find himself one day, in a town of Illinois, sixteen miles from Jacksonville, with but a few pennies in his pocket, and no friend within a thousand miles to whom he could look for help. He had just walked from Jacksonville, but his coat over his arm was his heaviest baggage. He placed himself at once in the avenues of business, on the sharp lookout for any opening that might offer. A great sale of property, which lasted three days, was just beginning, and the auctioneer was looking for some one to act as clerk of the sale.

This young man's face and genial air pleased him, and he was at once offered the situation, at two dollars a day. He went to work with a will, and by his winsome manner, ready wit, and obliging ways, won the hearts of the whole crowd before the first day was over. Such a young man those hearty Westerners felt they did not see every day. They must make a fixture of him. So, as soon as the sale was over, they offered him a position as teacher in one of their schools. This he gladly accepted, studying law in his leisure hours. His progress was rapid, and when twenty-one he opened his law office, and began regular practice. A year later he was by the legislature elected attorney-general of the state. The next year he was a member of the legislature. After that he was secretary of the State of Illinois, then judge of the supreme court for three years till elected to congress, where he served as representative and then senator till the end of his life.

Stephen A. Douglas, the young man from the Green Mountains, had high talents, but his pleasant manner, from the beginning to the end of his career, was what gained him the larger share of his popularity and success.

If the history of our citizens of wealth were written," says Hon. William E. Dodge, "we should find that fully three-fourths have risen from comparatively small beginnings to their present position."

VALUE OF CONCENTRATION.

ONE of the hardest tasks to master is to concentrate the whole attention upon the lesson of the morrow; for the student in college to prepare for the next recitation without running into the ball field, or allowing his gaze to wander around the room, or doing anything else in order to cheat himself out of what he ought to do. In study, as in business, we must not only strike the iron while it is hot, but strike it until it is made hot.

William A. Mowry tells a story of one of the foremost American scholars, who found himself spending two hours a day in preparing his Latin lessons. He determined to get that lesson in an hour and fifty minutes, and succeeded. When he afterwards sat down to learn his Latin he bent every energy to accomplish it in the shortest possible time. He found, by daily trials, that he could learn it in an hour and forty-five minutes, and that the time required was diminishing. Concentrating all his powers upon the task, day by day, he soon found himself studying only an hour and a half upon it, then five, ten, and even thirty minutes less. Encouraged, he redoubled his efforts, and within a few months the lesson could be learned in less than half an hour, a thing absolutely impossible with his habits of study when he entered the school.

It is not, indeed, the quantity of study that one gets through, or the amount of reading, that makes a wise man; but the appropriateness of the study to the purpose for which it is pursued; the concentration of the mind, for the time being, on the subject under consideration; and the habitual discipline by which the whole system of mental application is regulated. Abernethy was even of opinion that there was a point of saturation in his own mind, and that if he took into it something more than it could hold, it had the effect only of pushing something else out. Speaking of the study of medicine, he said: "If a man has a clear idea of what he desires to do, he will seldom fail in selecting the proper means of accomplishing it."

BE AN OAK, NOT A VINE.

THERE is, according to Dr. J. G. Holland, no surer sign of an unmanly and cowardly spirit than a vague desire for help, a wish to depend—to lean upon somebody and to enjoy the fruits of the industry of others. There are multitudes of young men who indulge in dreams of help from some quarter coming in at a convenient moment to enable them to secure the success in life that they covet. The vision haunts them of some benevolent old gentleman with a pocketful of money, and a trunkful of mortgages, and stocks, and a mind remarkably appreciative of merit and genius, who will, perhaps, give or lend them from ten to twenty thousand dollars, with which they will commence and go on swimmingly.

"To me," adds the same writer, "one of the most disgusting sights in the world is that of a young man with healthy blood, broad shoulders, and a hundred and fifty pounds, more or less, of good bone and muscle, standing with his hands in his pockets and longing for help. I admit that there are positions in which the most independent spirit may accept of assistance—may, in fact, as a choice of evils, desire it; but for a man who is able to serve himself, to desire the help of others in the accomplishment of his plans of life is positive proof that he has received a most unfortunate training, or that there is a leaven of meanness in his composition that should make him shudder."

THE CALL OF CITIZENSHIP.

WE WISH to maintain a republican form of government as a beacon to the world. Then it behooves each citizen to justify his ideal of republicanism in his own personality. Let us disprove the idea that America is the paradise of the commonplace, by aspiring to a higher degree of intellectual culture than we have yet attained. Let us show to the world that there is a dignity in a cultured mind and heart compared with which the honor of being descended from crowned heads and princes of the blood sinks into insignificance.

WHAT EXPERIENCE TEACHES.

EXPERIENCE teaches that we become that which we make ourselves. Every man stamps his own value upon himself, for we are great or little according to our will. We try to be honest, kind, and true, and little by little we become that for which we strive; and what once was difficult, by degrees becomes less and less so. Activity, goodness, benevolence, and temperance grow by use; and that which was once accomplished with effort becomes easy and natural. Thus a man may *make* himself generous, just, sympathetic, and magnanimous—civil, polite, forbearing, and gentlemanly.

SELF-RESPECT.

SELF-RESPECT is the noblest garment with which a man may clothe himself—the most elevating feeling with which the mind can be inspired. One of Pythagoras' wisest maxims, in his "Golden Verses," is that with which he enjoins the pupil to "reverence himself." Borne up by this high idea, he will not defile his body by sensuality, nor his mind by servile thoughts. This sentiment, carried into daily life, will be found at the root of all virtues—cleanliness, sobriety, chastity, morality, and religion. "The pious and just honoring of ourselves," said Milton, "may be thought the radical moisture and fountain head from whence every laudable and worthy enterprise issues forth." To think meanly of one's self, is to sink in one's own estimation as well as in the estimation of others. And as the thoughts are, so will the acts be. Man cannot aspire if he look down; if he will rise, he must look up. The very humblest may be sustained by the proper indulgence of this feeling. Poverty itself may be lifted and lighted up by self-respect; and it is truly a noble sight to see a poor man hold himself upright amidst his temptations, and refuse to demean himself by low actions.

Self-control and self-respect, its essential concomitant, ensure the production of that true type of man and citizen of whom it may well be written:

He serves his country best
Who lives pure life and doeth righteous deed,
And walks straight paths, however others stray,
And leaves his sons, as uttermost bequest,
A stainless record, which all men may read.

HOW HABIT GAINS IN STRENGTH.

HABIT gains in strength by repetition of the act. Penmanship is a habit of the hand, and so are knitting and sewing. As the habit is perfected we become less and less conscious of the act, and finally do it unconsciously. This is a very important principle in education. Mental processes, like speaking, writing, spelling, etc., must be made mechanical. Here is the right place for mechanical teaching by means of drill. These processes should be made almost wholly unconscious. It is practice and not the learning of rules, that accomplishes the result. These processes should also be made reflexes; as the spinal cord is the organ for reflex actions, we might almost say that spelling ought to be made a function of the spinal cord, like knitting and sewing. One has not been properly taught to spell a word if he can spell it only when he watches the spelling: he should be able to spell it correctly unconsciously. All mental energy expended in watching one's spelling, punctuation, pronunciation, etc. is wasted. If the schools will train students to speak, write, and spell almost entirely without conscious thought of these processes, they will set free mental energy for purposes of thinking, which is equivalent to "furnishing brains." A person who must watch his language when he expresses himself is hampered all his life.

TRUE COURAGE.

"THE greater part of the courage that is needed in the world is not of an heroic kind. Courage may be displayed in every-day life as well as on historic fields of action. The common need, is for courage to be honest, courage to resist temptation, courage to speak the truth, courage to be what we really are, and not pretend to to be what we are not, courage to live honestly within our means, and not dishonestly upon the means of others."

HABIT AND EDUCATION.

HABIT is, in a broad sense, a characteristic of all material things. The folds in your coat are habits of the texture of the cloth. Wood and iron frequently bent into special shape, tend to remain in that shape. There is a kind of inertia in matter in this respect. Comte called it the "indolence of nature." Physicists speak even of the "fatigue" of steel. All habits have a physical basis. Our mental and moral habits are based on the physiological habits of our nerve centers.

"It is not work that kills men," says Henry Ward Beecher, "it is worry. Work is healthy: you can hardly put more upon a man than he can bear. Worry is rust upon the blade. It is not the revolution that destroys the machinery, but the friction."

"You cannot dream yourself into a character; you must hammer and forge yourself one."

"The heights by great men reached and kept,
Were not attained by sudden flight;
But they, while their companions slept,
Were toiling upward in the night."

STUDENTS WHO HAVE BENEFITED THEMSELVES

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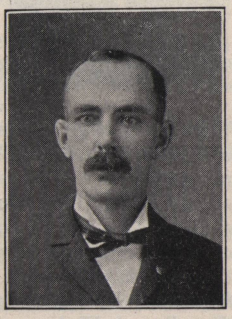
I have worked ever since I was twelve years of age, but today I possess a good mechanical education. I have finished the Complete Mechanical Course of The International Correspondence Schools, and have received their diploma. I have risen from an ordinary machinist to be a draftsman and designer, and now hold a responsible position with a good salary, which is largely due to the thorough course of instruction received. I am now taking the Electrical Engineering Course, and hope to rise still higher.—*Alex. McKendrick (C. 2452, M. E. 8369), Paterson, N. J.*

IS NOW A MUNICIPAL ENGINEER.

I am proud to acknowledge myself a graduate of The International Correspondence Schools. Immediately after completing my course, I applied for the position of engineer for Plymouth, Pa. The fact that I held the Schools' Diploma, obtained the position for me. After I had been working one year, the council unanimously recommended my reelection, on account of very satisfactory work. In 1898 I was elected for the same position, and also as engineer for Edwardsville. In addition to this work I am able to do considerable outside surveying, mapping, etc. As long as I live, I will endeavor to be a credit to the School to which I owe so much.—*David Thomas (S. M. 80, B. 228), Plymouth, Pa.*

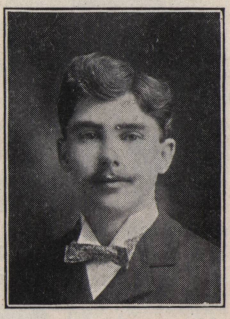
ENGINEER IN CHARGE OF A LARGE PLANT.

It affords me great pleasure to say a good word for The International Correspondence Schools. I completed the Stationary Engineering Course nearly two years ago, and at once took up the Electrical Engineering Course. During this time, I have been able to accept, in succession, two positions of responsibility, neither of which I could have filled but for the instruction received from the Schools. I have advanced from running a 7″×9″ simple engine to a 400-horsepower compound-condensing engine for a street-railway plant, and the usual electrical apparatus. The Schools are doing more to elevate the standard of engineers and electricians than any other agency, and will always receive my hearty support.—*Horace A. Dodge (H. 1353, M. E. 1616, A. D. 147), Pres. Association No. 22, N. A. S. E., Rockford, Ill.*



HAS BECOME AN ELECTRICIAN AND INVENTOR.

I cannot recommend The International Correspondence Schools too highly. Since taking the Electrical Power and Lighting Course, I have become electrician for the New Union Station, St. Louis, Mo. From the knowledge gained in the Course, I have been able to invent and successfully procure patents on mechanical and electrical devices in the United States, Canada, Great Britain, Germany, and France.—*Geo. P. McDonnell (J. 113, H. 7665), St. Louis, Mo.*



FROM TRAPPER TO SUPERINTENDENT.

I have worked in and around mines for upwards of 27 years, and have advanced myself from trapper to superintendent. I supplemented my practical experience by devoting all my spare time to the study of the Complete Coal Mining Course of The International Correspondence Schools, and acquired a thorough theoretical knowledge of mining. This knowledge has enabled me, on several occasions, to successfully meet severe tests of my ability as a surveyor. In one case I ran an entry 500 feet, almost a half circle in shape. The workmen started at each end and the connection was perfect. All my theoretical knowledge I gained through the Schools.—*James Macleery (C. M. 34, S. M. 120), East Branch, W. Va.*

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CHIEF MACHINIST ON A WARSHIP.

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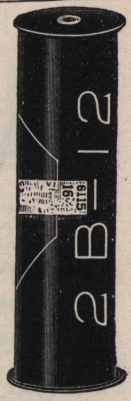

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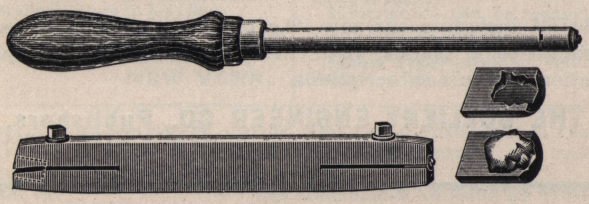

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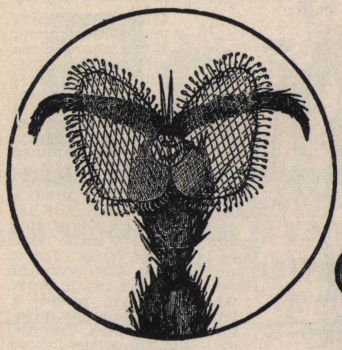

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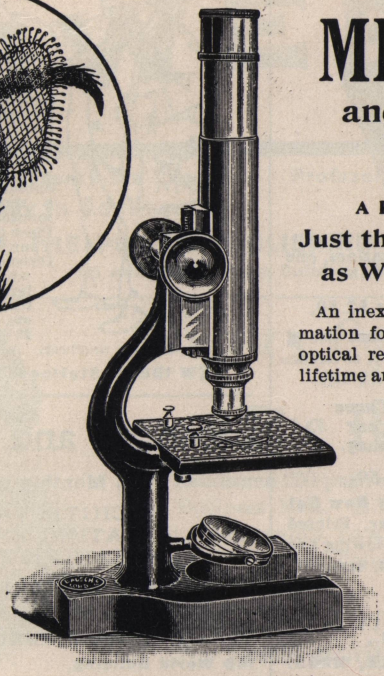

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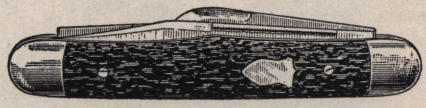

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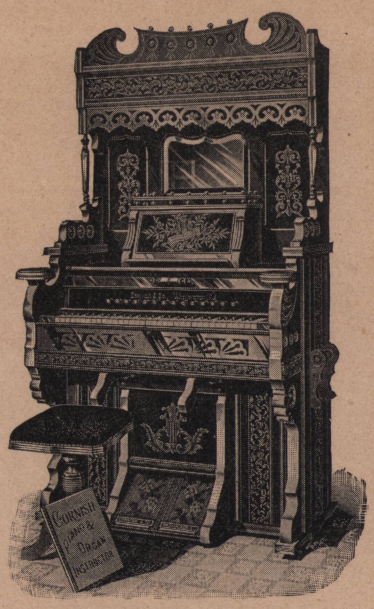

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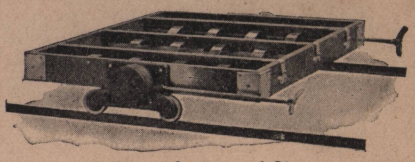

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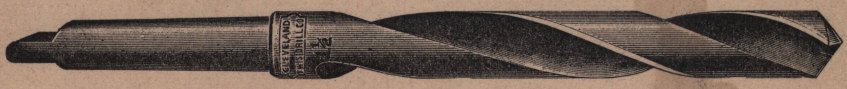

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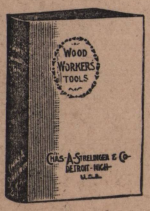

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